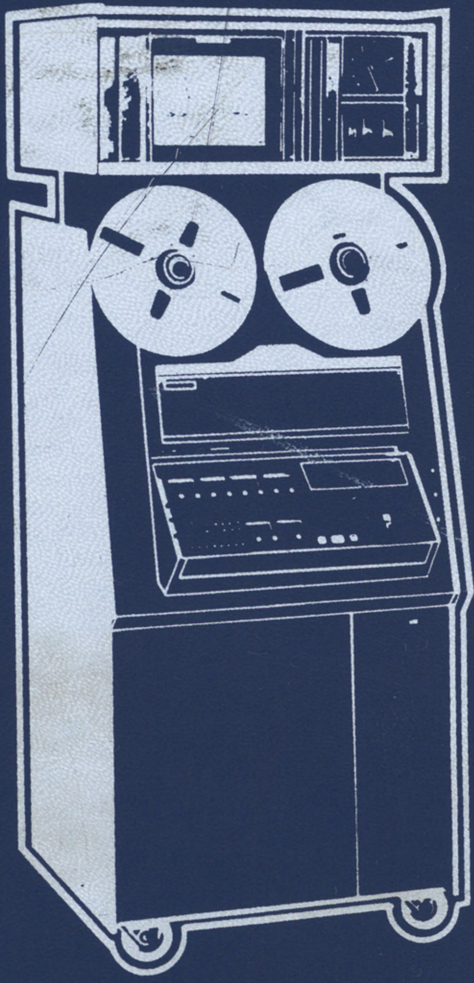
VPR-3

VIDEO PRODUCTION RECORDER

SERVICE MANUAL 1809594



AMPEX

Catalog No. 1809594-02
Issued: August 1985

VPR-3

VIDEO PRODUCTION RECORDER

SERVICE MANUAL

Received 12/18/85

AMPEX

Prepared by

AVSD Technical Publications
Ampex Corporation
401 Broadway
Redwood City, CA 94063

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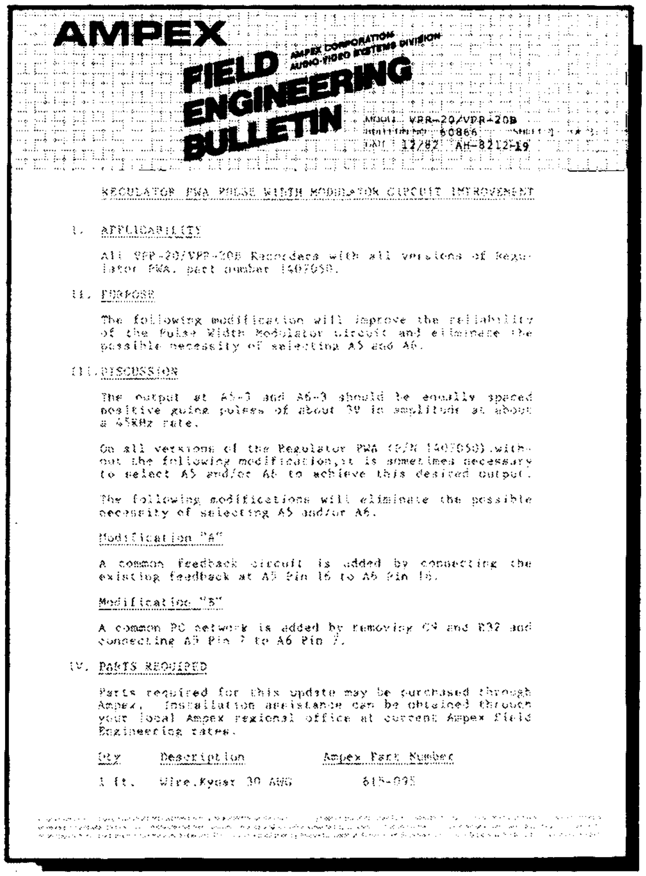
Issued: August 1985

FOR ADDITIONAL TECHNICAL INFORMATION

FIELD ENGINEERING BULLETIN SERVICE

The Ampex Audio-Video Systems Division's Technical Support Group publishes Field Engineering Bulletins (FEBs) describing approved equipment modifications, special tools and accessories plus information on improved operating and maintenance techniques.



AMPEX
FIELD ENGINEERING BULLETIN
AMPEX CORPORATION
AUDIO-VIDEO SYSTEMS DIVISION

MODEL VPR-20/VPR-20B
BULLETIN NO. 60866 SHEET 1 OF 3
DATE 12/82 AH-8212-19

REGULATOR PWA PULSE WIDTH MODULATOR CIRCUIT IMPROVEMENT

I. APPLICABILITY

All VPR-20/VPR-20B Recorders with all versions of Regulator PWA, part number 1407050.

II. PURPOSE

The following modification will improve the reliability of the Pulse Width Modulator circuit and eliminate the possible necessity of selecting A5 and A6.

III. DISCUSSION

The output at A5-3 and A6-3 should be equally spaced positive going pulses of about 3V in amplitude at about a 45KHz rate.

On all versions of the Regulator PWA (P/N 1407050) without the following modification, it is sometimes necessary to select A5 and/or A6 to achieve this desired output.

The following modifications will eliminate the possible necessity of selecting A5 and/or A6.

Modification "A"

A common feedback circuit is added by connecting the existing feedback at A5 Pin 16 to A6 Pin 16.

Modification "B"

A common RC network is added by removing C9 and R32 and connecting A5 Pin 7 to A6 Pin 7.

IV. PARTS REQUIRED

Parts required for this update may be purchased through Ampex. Installation assistance can be obtained through your local Ampex regional office at current Ampex Field Engineering rates.

Qty	Description	Ampex Part Number
1 ft.	Wire,Kynar 30 AWG	618-095

To receive these bulletins,
send us the following information:

Owner's Name
Owner's Address

Model No.
Serial No.
Date of Purchase

Dealer's Name
Dealer's Address

In the United States send to:

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Audio-Video Systems Division
Technical Support Group
401 Broadway, Mail Stop 3-46
Redwood City, California 94063

Outside United States send to:

YOUR NEAREST SALES COMPANY

(Addresses on rear of this page)

TRAINING SERVICES

Technical (maintenance) training on this and other Ampex video, audio, disc and instrumentation products is offered on a scheduled basis at Corporate Headquarters in Redwood City, California, and at Headquarters European Area in Reading, England. For further information regarding this training, please contact your local Ampex Sales Office.

SALES/SERVICE OFFICES

UNITED STATES

CALIFORNIA
500 Rodier Drive
Glendale, CA 91201
(213) 240-5000

401 Broadway
Redwood City, CA 94063-3199
(415) 367-2202

GEORGIA
1872 Montreal Road
Tucker, GA 30084
(404) 491-7112

ILLINOIS
719 W. Algonquin Road
Arlington Heights, IL 60005
(312) 593-6000

MARYLAND
10215 Fernwood Road
Bethesda, MD 20817
(301) 530-8800

NEW JERSEY
5 Pearl Court
Allendale, NJ 07401
(201) 825-9600

OHIO
4130 Linden Avenue
Dayton, OH 45432
(513) 254-6101

TEXAS
3353 Earhart Drive
Carrollton, TX 75006
(214) 960-1162

UTAH
2880 South Main, Suite 111
Salt Lake City, UT 84115
(801) 487-8181

AMPEX CORPORATION
AUDIO-VIDEO SYSTEMS DIVISION
401 BROADWAY
REDWOOD CITY, CALIFORNIA 94063
(415) 367-2011

Effective: 1 October 1984

INTERNATIONAL

AUSTRALIA
Ampex Australia Pty. Ltd.
P.O. Box 199
55-61 Talavera Road, Unit A
North Ryde, 2113
New South Wales, Australia

21 Terra-Cotta Drive
Blackburn
Victoria, Australia

BAHRAIN
Ampex World Operations
Abu Fateh Building, #499
Road 1706, Diplomatic Area
P.O. Box 26627
State of Bahrain

BELGIUM
Ampex S.A. Nivelles
Rue de l'Industrie, 8
1400 Nivelles, Belgium

BRAZIL
Ampex do Brasil Electronica Ltda.
Rua Visconde de Piraja 595,
Grupo 1104
Ipanema - 22410
Rio de Janeiro, RJ Brazil

CANADA
Ampex Canada Inc.
1770 Argentia Road
Mississauga, Ontario
Canada, L5N 3S7

1116-55 Avenue, N.E.
Calgary, Alberta
T2E 6Y4, Canada

729 Meloche Avenue
Dorval, Quebec
H9P 2S4, Canada

COLOMBIA
Ampex South America
Apartado Aereo 29613
Carrera 16A Nr. 79-25
Bogota, Colombia

CYPRUS
Ampex World Operations, S.A.
Apt. 802, Ghinis Building
58-60 Dighenis Akritas Ave.
Nicosia, Cyprus

ENGLAND
Ampex International
Acre Road, Reading
Berkshire, RG2 OQR, England

Ampex Great Britain Ltd.
Acre Road, Reading
Berkshire, RG2 OQR, England

FRANCE
Ampex SARL
Courcellor I,
2 Rue Curnonsky
75017 Paris, France

GERMANY
Ampex Europa GmbH
Walter-Kolb-Str. 9-11
6000 Frankfurt (Main) 70
West Germany

HONG KONG
Ampex World Operations, S.A.
Rooms 908-911, 9th Floor
TSIM SHA Centre (East Wing)
66 Mody Road
Tsim Sha Tsui East
Kowloon, Hong Kong

ITALY
Ampex Marketing Services SRL
Casella Postale 10720
00143 Rome
Rome, Italy

Ampex Italiana S.p.A.
4 Via Riccardo Gigante
00143 Rome, Italy

Ampex Italiana S.p.A.
Via Cristoforo Colombo, 48
20090 Trezzano Sul Naviglio
Milano, Italy

JAPAN
Ampex Japan Ltd.
P.O. Box 15
Tokyo Ryutsu Center
6-1-1 Heiwajima, Ota-ku
Tokyo 143, Japan

MEXICO
Ampex de Mexico, S.A. De C.V.
Apdo, Postal No. 13-615
Division del Norte No. 1832
Col. Postales
Delegacion Benito Juarez
Mexico 13, D.F. 03300

NETHERLANDS
Ampex B.V.
P.O. Box 9026
Colorado-Dreef 36
3506 GA Utrecht, The Netherlands

SINGAPORE
Ampex International Sales Corp.
151 Chin Swee Road #08-13
Manhattan House
Singapore 0316
Republic of Singapore

SPAIN
Ampex Trading Co. S.A.
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5th Floor C & D
Madrid 8, Spain

SWEDEN
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P.O. Box 7056 (Rissneleden 8)
S-172 07 Sundbyberg, Sweden

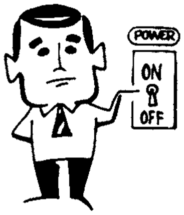
SWITZERLAND
Ampex World Operations S.A.
Rue de Simplon 13
1700 Fribourg
Switzerland

VENEZUELA
OTACCA-AMPEX
Apartado 76825
Caracas 1070-A
Venezuela

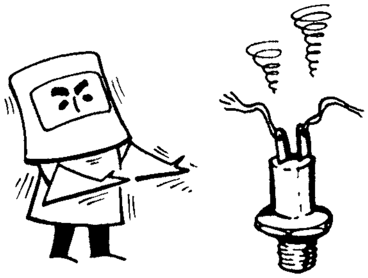
SAFETY AND FIRST AID SUGGESTIONS

Regardless of how well electrical equipment is designed, personnel can be exposed to **dangerous electrical shock** when protective covers are removed for maintenance or other activities. Therefore, it is incumbent on the user to see that all safety regulations are consistently observed and that each individual assigned to the equipment has a clear understanding of first aid related to electrical hazards.

In addition, the following safety practices must be followed:



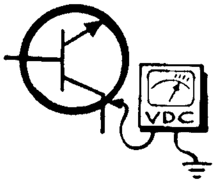
1 Do not attempt to adjust unprotected circuit controls or to dress leads with power on.



2 Do not touch heavily loaded or overheated components without precaution to avoid burns.

3 Do not assume that all danger of electrical shock is removed when power is **off**. Charged capacitors can retain dangerous voltages for a long time after power is removed. These capacitors should be discharged through a suitable resistor before any circuit points are touched.

4 Always avoid placing parts of the body in series between ground and circuit points.



5 Remember that some semiconductor cases and solid-state circuits carry high voltages.

6 Don't take chances. Be fully trained. Ampex equipment should be operated and maintained by fully qualified personnel.

If someone seems unable to free himself while receiving an electrical shock, **turn power off** before attempting to render aid. A muscular spasm or unconsciousness can make a victim unable to free himself from the electrical power.

WARNING

DO NOT TOUCH VICTIM OR HIS CLOTHING BEFORE POWER IS REMOVED OR YOU MAY ALSO BECOME A SHOCK VICTIM.

If power cannot be removed immediately, **very carefully** loop a length of dry nonconducting material (such as rope, insulating material, or clothing) around the victim and pull him free of the power. Carefully avoid touching him or his clothing until free of power. Immediately start the appropriate first aid procedures.

GOOD PRACTICES

In maintaining the equipment covered in this manual, please keep in mind the following standard good practices:

1. When connecting any instrument (oscilloscope, waveform monitor, etc.) to a high-frequency output, use the appropriate termination resistor at the input of the instrument, unless the instrument is terminated internally.
2. When inserting or removing printed wiring assemblies (PWAs), cable connectors, or fuses, always turn off power to the affected portion of the equipment. After power is removed, allow sufficient time for the power supplies to bleed down before reinserting PWAs.
3. When troubleshooting, remember that FETs and other metal-oxide-semiconductor (MOS) devices may appear defective because of leakage between traces or component leads on the printed wiring board. Clean the printed wiring board and recheck the MOS device before assuming it is defective.
4. When replacing MOS devices, follow standard practices to avoid damage caused by static charges and soldering.
5. When removing components from PWAs (particularly ICs), use care to avoid damaging PWA traces.

WARNING

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case, the user, at his own expense, will be required to take whatever measures may be necessary to correct the interference.

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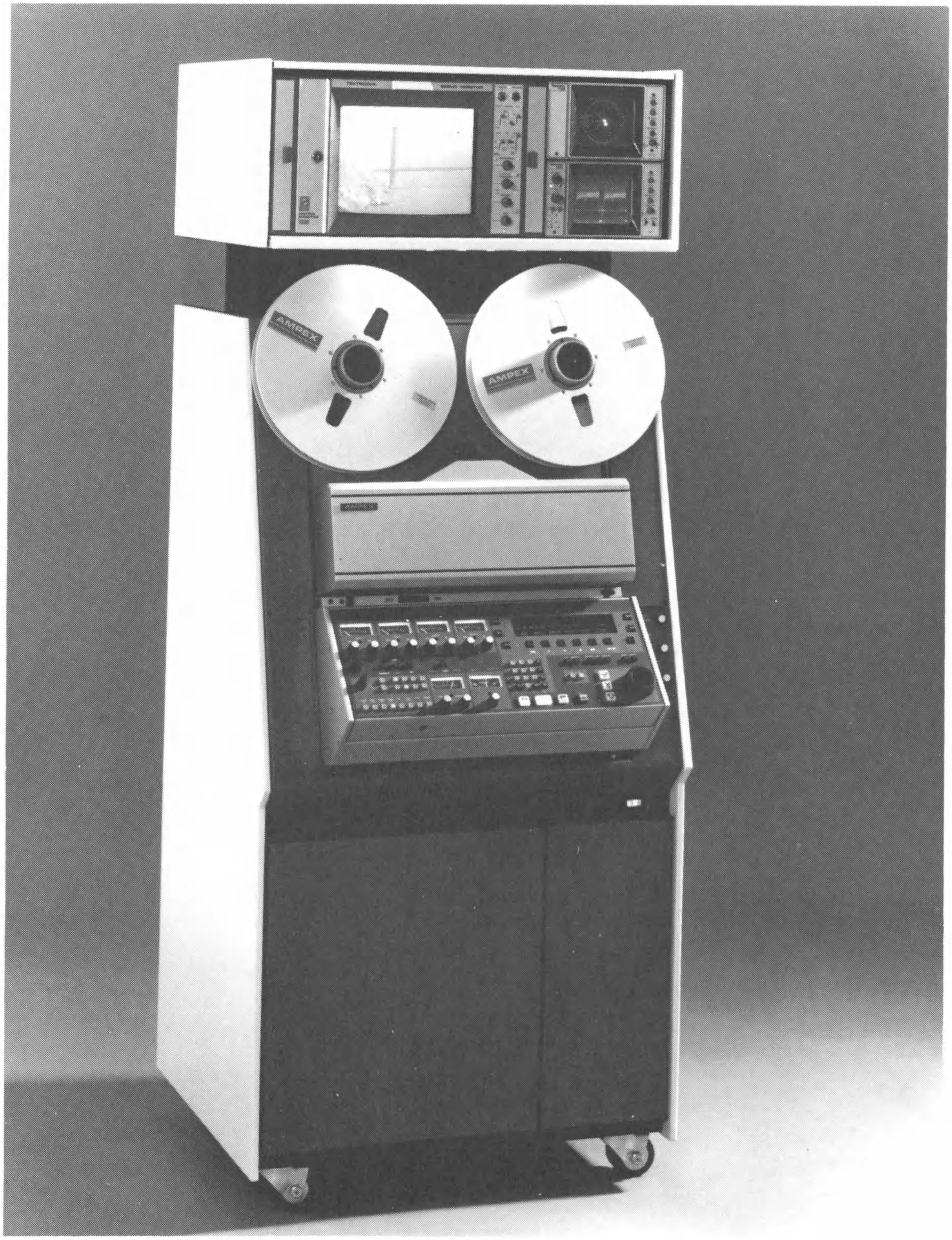

VPR-3 Video Production Recorder

SECTION 1
GENERAL INFORMATION

1-1 PURPOSE AND SCOPE OF MANUAL

This manual provides theory of operation as well as maintenance information and instructions for the VPR-3 Video Production Recorder. Information and instructions herein are intended for use by trained service personnel only.

The manual is divided into nine sections.

- Section 1 contains information on VPR-3 capabilities, physical and functional descriptions, standard and optional equipment, and specifications, as well as information on related publications, required test equipment, and alignment tapes.
- Section 2 provides overall system block diagrams, and text that describes the systems. The video signal system, control and reference system, servo system, transport system, audio system, power supply system, and air system are described.
- Sections 3 through 9 contain theory of operation discussions and illustrated test and adjustment procedures for each system in the VPR-3. These sections include functional descriptions of each PWA and assembly, adjustment procedures, jumper position tables, component location illustrations, and waveforms. Section 3 describes the video signal system, and Section 4 the control and reference system. Section 5 covers the servo system, Section 6 the transport system, Section 7 the audio system, Section 8 the power supply system, and Section 9 describes the air system.

1-2 INTENDED USE OF EQUIPMENT

The VPR-3 is a 1-inch, one-field-per-scan, helical teleproduction videotape recorder, compatible with all standard features specified in the SMPTE Type C and EBU Format C specification for 1-inch, helical scan videotape recordings. It is available in three mounting configurations: lowboy console (with or without a monitor bridge), rack, or table top.

1-3 BROADCAST STANDARD

The VPR-3 can be configured to operate in NTSC, PAL-I, PAL-M, or SECAM color television systems. Information herein covers all VPR-3 color video system configurations.

1-4 RELATED PUBLICATIONS

Other publications containing information on the VPR-3 are listed in Table 1-1.

Table 1-1. Publications Relating to the VPR-3 System

Publication	Ampex Catalog No.
VPR-3 Installation and Operation	1809593
VPR-3 Parts Lists and Schematics	1809641 and 1809642 (Volumes 1 and 2)
VPR-3 Diagnostics Maintenance Manual	1809650
TBC-3 (NTSC) Service Manual	1809606
TBC-3 (PAL/SECAM) Service Manual	1809636
TBC-3 Installation and Operation	1809605
TBC-3 Parts Lists and Schematics	1809607

1-5 Installation and Operation Manual

The *VPR-3 Installation and Operation* manual is part of the VPR-3 Miscellaneous Parts Kit furnished with every VPR-3. Information and instructions are for the guidance of personnel responsible for VPR installation and operation, and are essential to VPR-3 maintenance. The *VPR-3 Service Manual* assumes the technician's familiarity with installation and operation information.

1-6 Diagnostics Maintenance Manual

The *VPR-3 Diagnostics Maintenance* manual describes to VPR operators and maintenance personnel how to use expanded diagnostics software for identifying and isolating system faults and for field troubleshooting of many key VPR-3 circuits.

1-7 Parts Lists and Schematics Manual

The *VPR-3 Parts Lists and Schematics* manual is also part of the miscellaneous parts kit, and contains complete parts lists, schematics, and parts location drawings for all VPR-3 subsystems and PWAs. Drawing information enables the technician to find components referenced in the service manual. Parts lists enable positive component identification for part replacement purposes.

1-8 TBC-3 Installation and Operation Manual

The *TBC-3 Installation and Operation* manual describes procedures for interconnecting the TBC-3 Digital Time-Base Corrector to the VPR-3 Video Production Recorder and other compatible video tape recorders. The manual also describes functions of TBC-3 controls and indicators.

1-9 TBC-3 Service Manual

The *TBC-3 Service Manual* contains instructions for aligning and maintaining the TBC-3 Digital Time-Base Corrector. Two service manuals are available—one contains maintenance information for TBC-3s operating in NTSC broadcast standard, and the other contains maintenance information for TBC-3s operating in PAL/SECAM broadcast standards.

1-10 TBC-3 Parts Lists and Schematics

TBC-3 Parts Lists and Schematics contains complete parts lists, schematics, and parts location drawings for all TBC-3 subsystems and PWAs. This information enables the technician to find components referenced in the TBC-3 service manual and to identify components for part replacement purposes.

1-11 SOFTWARE

The VPR-3 is software-programmable; the program stored in electronics bay PROMs on the Control PWA governs the VPR's operational characteristics and capabilities. Software enhancements which increase VPR-3 capabilities (and which may alter its characteristics) are released periodically in an ongoing product improvement program. Each software release, or package, is designated numerically. At the publication date of this manual, software packages 1.0 through 5.3 are in effect. Each subsequent software package will be designated with a higher number.

Software packages will either be incorporated in the VPR-3 at manufacture, or will be made available to VPR-3 users as an optional enhancement. Subsequent software packages will be made available in the form of programmed PROM chips which are clearly placarded with the Ampex part number and the software package designation. PROM chips are mounted in IC sockets on the Control PWA, and PROM chip replacement is straightforward.

1-12 Effective Software

Software version in use in the VPR-3 can be determined from the Setup Select menu, which appears on the fluorescent display panel when the **setup** key in the Home menu is pressed. Machine configuration (NTSC, PAL, SECAM, etc.) and software version on the top line are displayed as shown:

NTSC 4.0

Vide **Audio** **Servo** **Tape** **Chgen** **Tcgen**

1-13 Diagnostics Software and Equipment

Optional VPR-3 Expanded Diagnostics, which continuously monitors many critical operating parameters, is included in Versions 4.0 and higher of the VPR-3 operating system software. It includes a logic probe, and is essential for efficient field troubleshooting of many key VPR-3 microprocessor-driven circuits.

1-14 Diagnostics Program Organization

The VPR-3 diagnostics program, which is included in the VPR-3 operating system software, is organized into six parts. These are entered through the main Diagnostics menu, which appears when the **diag** soft key on the Home menu is pressed. The six parts of the diagnostics program are:

- **Continuous diagnostics**—monitors fault conditions, nonstandard setup, servo status, power supply voltages, control board battery voltage, line voltage, and various transport status conditions.
- **Board diagnostics**—measures key voltages on Control and Reference PWAs.
- **Servo diagnostics**—measures capstan and scanner current, plus supply and takeup tension arm voltages.
- **Power supply diagnostics**—measures and displays the various power supply voltages.
- **Control panel diagnostics**—tests different parts of the operator control panel.
- **Probe diagnostics**—uses a diagnostic probe to verify proper communication between the Control PWA and other PWAs on the system bus by checking key test points on PWAs.

1-15 Software Enhancements

Software enhancements of interest to VPR-3 users are described in Field Engineering Bulletins (FEBs) published by Ampex Corporation Audio-Video Systems Division Technical Support Group. FEBs also explain approved hardware modifications, or provide information on improved operating or maintenance techniques.

If you subscribe to FEBs, as outlined on page iii at the front of this manual, we suggest they be filed for reference in the back of this manual.

1-16 MAINTENANCE POLICY

The following paragraphs briefly summarize Ampex policy for VPR-3 maintenance and technical support. Warranty of material and workmanship, and utilization of Ampex technical support facilities are described.

1-17 Warranty

Details of warranty coverage are given in the *Terms and Conditions of Sale* agreement—an integral part of every Ampex Sale Contract. Unless specific exceptions are noted on the contract, Ampex warrants to the original purchaser that the VPR-3 will be free from defects in material and workmanship for one year from the date of shipment by Ampex. Two exceptions apply: the warranty period for motors is 90 days, and the warranty period for helical video heads is 9 months or 500 hours of operation, whichever comes first. Please refer to *Terms and Conditions of Sale* to determine warranty coverage in effect at the time you purchased your VPR-3.

1-18 Technical Support

If the purchaser/user experiences technical difficulty with the VPR-3, service and assistance are available at the nearest Ampex regional sales office, regardless of whether or not the warranty period has expired. A list of these offices is shown on page iv at the front of this manual. Parts should be returned to the Ampex factory or service center only with prior written authorization from Ampex. All liaison with Ampex technical support services should be made through regional sales office.

1-19 Logistic Support

A selection of logistic support plans is made available to all Ampex customers. Each plan involves a spare parts kit which may be composed of entire subassemblies, PWAs, or component parts, such as integrated circuits. These kits are made available in addition to the Miscellaneous Parts Kit (see paragraph 1-22), and accessory kits (see paragraph 1-23). The range of logistic support plans is quite flexible, and arrangements can be tailored to individual operational requirements and budget considerations. Contact the appropriate regional sales office for details.

1-20 Recommended Tools and Test Equipment

VPR-3 maintenance and servicing should be done in a well-lighted, dust-free, and temperature-controlled environment. The maintenance facility should be equipped with tools, test equipment, and other special-purpose items listed in Table 1-2. Test equipment with equivalent-or-better specifications can be substituted for equipment suggested in the table. In addition, the miscellaneous parts kit (paragraph 1-21) and the maintenance and service tool kits (paragraph 1-23) are essential to proper VPR-3 maintenance.

Table 1-2. Recommended Tools and Test Equipment

Equipment Type	Suggested Model	Used For
Waveform monitor	Tektronix Model 1485	Video signal system alignment and servicing.
Tip projection gauge	Ampex P/N 1401000	Measuring head-tip projection.
Scanner shipping and carrying case	Ampex P/N 1401347	Shipping scanner assembly.
Head demagnetizer	Ampex P/N 4040575	Demagnetizing audio and video heads, tape guides, and capstan (115V operation only).

(Continued next page)

Table 1-2. Recommended Tools and Test Equipment (Continued)

Equipment Type	Suggested Model	Used For
Bulk demagnetizer	Taberaser	Demagnetizing trim plates and other large components in tape path.
Head cleaner	Ampex P/N 087-007	Cleaning heads, scanner, capstan shaft, and tape guides.
Precision plastic shim stock; 2, 12, and 14 mil	Artus Corp.	Capstan hub replacement; pin-to-scanner gap measurement.
Gram gauge, -1grams	Correx Co. Model 475-15	Pin-to-scanner gap measurement.
Tape tension gauge	Tentel T2-H18-CBD (Ampex P/N 360/497)	Measuring tape tension.
Feeler gauge	Starrett Model 467	Measuring various transport clearances.
Gram gauge, 0-10g	Ametek, Hunter Co.	Measure AST brush pressure.
Soft lint-free wipes Cotton-tipped swabs	Ampex P/N 110-015 Ampex P/N 650-080	Various cleaning and component replacement procedures.
Brush separator (plastic)	Ampex P/N 1408197	For installing AST brushes.
Locator-brush housing	Ampex P/N 1408148	For installing AST brushes.
Flutter meter	Micom (Bahrs) Model 8100-W	Measuring transport flutter and tape speed.
AC voltmeter	Hewlett-Packard Model 400FL or 3400A	Audio system performance check and alignment.
Digital voltmeter	Hewlett-Packard Model 3435A	General servicing and power supply check.
Frequency counter	Hewlett-Packard Model 5300A/5302A	Measuring tape speed.
Wideband oscilloscope with high gain preamplifier	Tektronix Model 7603 with 7A13, 7A26, and 7B53A plug-ins	Alignment and servicing.

(Continued next page)

Table 1-2. Recommended Tools and Test Equipment (Continued)

Equipment Type	Suggested Model	Used For
Current transformer probe	Tektronix Model CT-2, P/N 015-046 mV/mA into 50Ω	General servicing and adjusting video.
Television signal generator	Tektronix Model 1410 (NTSC) 1411 (PAL) with color bar, multiburst, linearity, pulse and bar, and sync generator modules.	Video signal system alignment and servicing.
Spectrum analyzer	Hewlett-Packard Model 141T RF Section 8553B IF Section 8552B Tracking Gen. 8443A	Video signal system alignment.
Spectrum analyzer	Hewlett-Packard Model 3580A	Audio harmonic distortion and erasure check.
Video noise meter	Rohde and Schwarz Model BN120312	Measuring video signal-to-noise ratio.
Audio oscillator	Hewlett-Packard Model 651B or 209A	Audio system performance check and alignment.
Color picture monitor	Tektronix Model 655 (NTSC/PAL)	Video signal system alignment and servicing.
Vectorscope	Tektronix Model 520 (NTSC)	Video signal system alignment and servicing.
Group delay meter	Rohde and Schwarz Model BN42392	Video signal system alignment and servicing.

1-21 Miscellaneous Parts Kit

The VPR-3 Miscellaneous Parts Kit (Ampex No. 1467820) is furnished as standard equipment with each VPR-3.

1-22 Accessory Kits

The C-Format Maintenance Tool Kit, an accessory tool kit, and other VTR maintenance equipment useful in servicing the VPR-3 are available from Ampex.

1-23 Reference and Alignment Tapes

Ampex reference and alignment tapes are listed in Table 1-3. Some tapes are included in the maintenance tool kit, while others listed in this table can be ordered separately.

Table 1-3. VPR-3 Reference and Alignment Tapes

Ampex Catalog No.	Standard	Description
1498600	525/NTSC	Audio alignment
1498601	625/PAL	Audio alignment
1498602	525/NTSC	Audio flutter (3 kHz at 9.6063 in/s)
1498603	625/PAL	Audio flutter (3 kHz at 9.4409 in/s)
1498604	525/NTSC	Highband carrier video reference
1498605	625/PAL	Highband carrier video reference
1498606	625/SECAM	Highband video reference
1498608	525/NTSC	Guide adjustment
1498609	625/PAL	Guide adjustment
1498614	625/PAL	Biased control track reference level (1 kHz at 9.4409 in/s, 100 nWb/m)
1498623	525/NTSC	Video and audio reference (recorded in accordance with SMPTE document V16.4-634)
1498625	525/NTSC	Programmed dropout
1498626	525/PAL	Programmed dropout

Every Ampex alignment tape is a first-generation original, produced by specially modified master recorders. Before any reference or alignment tape is recorded, each machine is carefully aligned and calibrated to a master vault tape. It is then monitored continuously to assure absolute compliance and adherence to frequency reproduction and other measurement parameters. Though voice tags are dubbed, all test signals are supplied directly to record amplifiers from the most accurate programmable tone and signal generators available.

1-24 Caring for Alignment Tapes

Due to the precise nature of alignment tapes, certain precautionary measures should be taken to prolong their usefulness. One enemy of magnetic tape is physical deterioration. Tape-edge deformation, for example, can result in uneven tracking. Edge deformation occurs whenever tape is unevenly spooled and subsequently crushed by the reel flanges. Care should be taken to allow for a smooth, compact tape pack, during both play and shuttle modes.

Magnetized heads and tape guides must be avoided. It is essential to clean and demagnetize them frequently.

Alignment tapes should always be stored in a safe, dry environment. Fluctuating temperatures and humidity can have an adverse effect on tape base material, causing it to alternately swell and shrink. Resulting tape degradation impairs tape's usefulness as a reference tape. When an alignment tape is played, it should never be stopped during the middle of a test. If a mistake occurs, allow the tape to play through to the end, and then rewind it carefully and start again. Stopping and starting a tape during a pass results in unnecessary tape tension changes, thus increasing the possibility of tape stretch and distortion of the recorded signal.

Finally, two factors which cannot be ignored: wear and age. Each time a tape is played, physical wear and signal deterioration occur. Thus, an alignment tape should be carefully monitored, and after 20 to 25 passes, or one to two years of use, it should be replaced.

1-25 SAFETY REQUIREMENTS

Wear safety glasses when servicing power chassis assemblies. Power supply components can explode.

1-26 SERVICING HINTS

- Always turn off power before removing or installing PWAs.
- Allow power supply to bleed down after turning power off for power supply component removal. Wait a minimum of 30 seconds after turning off power before removing or replacing a PWA in the power chassis assembly.

1-27 HANDLING DEVICES SUSCEPTIBLE TO DAMAGE BY STATIC DISCHARGE

CAUTION

THE VPR-3 USES SOLID STATE DEVICES, INCLUDING FET AND CMOS COMPONENTS. ALL SOLID STATE DEVICES, AND ESPECIALLY FET AND CMOS DEVICES, CAN BE DAMAGED BY STATIC ELECTRICITY. PRECISION METAL FILM RESISTORS CAN ALSO BE DAMAGED AND MUST BE HANDLED PROPERLY.

Improper handling of devices susceptible to static damage can cause:

- **Destruction**—Instantaneous current flow that results in melting of metal oxides and other components.
- **Life degradation**—Lesser damage that results in unplanned leakage current and causes early device failure.
- **Inaccurate operation**—Transient-induced currents and polarization cause the device to function in an unplanned sequence.

Data in Table 1-4 indicates how much static voltage a person can generate under various circumstances. It is important to note that a person cannot feel a charge of less than 2000—4000 volts.

Table 1-4. Static Voltages Vs Humidity

Source	20% RH	80% RH
Walking across vinyl floor	12 kV	0.25V
Walking across synthethic carpet	35 kV	1.5 kV
Arising from foam cushion	18 kV	1.5 kV
Picking up polyethylene bag	20 kV	600V
Triggering vacuum solder remover	8 kV	1 kV
Aerosol circuit freeze spray (Freon)	15 kV	5 kV
Cleaning a circuit with an eraser	12 kV	1.0 kV
You cannot feel a charge of less than 3000–4000 volts.		

Table 1-5 shows susceptibility of various components to ESD voltage.

Table 1-5. Susceptibility Ranges of Various Devices Exposed to ESD

Device Type	ESD Susceptibility (Volts)
MOSFET	100 - 200
HEXFET	500 - 5,000
JFET	140 - 10,000
CMOS	250 - 2,000
Schottky Diodes, TTL	300 - 2,500
Bipolar Transistors	380 - 7,000
ECL	500 - 4,000
SCR	680 - 1,000

Precautions that help control static damage include:

- Wear a wrist strap. Remember to put it on and connect it to ground before beginning work. Wrist straps are available from 3M corporation (Model 2066, 2067, or 2071) and Bemis Co. (Part Number 34255 for wrist strap and conductive mat). If you make your own strap, be sure to include, close to your wrist, a 1 Megohm resistor in series with the ground lead. This is an absolute must for safety.
- Work on a grounded conductive surface or mat (3M Model 1872), or use black conductive foam. Do not insulate PWAs from the conductor surface with

bubble wrap, clear plastics, paper, white or pink foam. A portable field service kit is available from 3M (Model 8012) or Bemis (Part Number 34255) which consists of a wrist strap and conductive work surface.

- Keep all plain plastics and nonconductors out of your static-safe area.
- Do not allow ungrounded personnel to touch static-sensitive componenets or PWAs.
- Treat all components as if they are static sensitive.
- Static-sensitive ICs and other static-sensitive components should be stored or transported only in static shielded bags, conductive black boxes, or black conductive foam. Antistatic IC tubes should be inside a static shielded bag. Individual static-sensitive devices should have leads grounded in black conductive foam.
- Static-sensitive PWAs should be in black conductive boxes, or in pink or black static shielded bags. Do not carry PWAs unless the are in static shielded bags. Do not transport static-sensitive devices on a rolling cart.
- Soldering irons should have grounded tips and zero crossing heat controls to eliminate EMI. Suggested vendors:

Vendor	**Part No.**
Weller	EC2000
Weller Pencil	TB 2012
Hexacon	Thermaltrac
Ungar	9000

- Do not spray freeze-spray onto static sensitive components.
- Ohmeters used to test static-sensitive devices must not have more than 25V present on their test leads. Touch ground first with the leads before probing devices.
- Always turn off power, and wait at least 30 seconds before removing a circuit board (PWA).
- Be sure test equipment is grounded.
- Chairs or stools (especially those on rollers) should have a conductive seat cover which is grounded along with the chair; or they can be sprayed with an antistatic solution.
- Use a conductive type desoldering device solder sucker. Suggested vendors:

Vendor	**Part No.**
Paladin	PA1704
Richmond	SC1340
EDSYN	AS196 Soldapullt

- Be especially careful when troubleshooting or replacing components on the reel MDA, Capstan/Scanner MDA, Regulator PWA, and Motor Drive PWA (inside scanner). These PWAs contain power FETs which can be easily damaged by static charges.

- Clothing must never come into contact with components or PWAs. Short-sleeved shirts should be worn.

Static can also be reduced by:

- Air ionizers
- Conductive floor wax and mats
- Static meters for measuring static voltages
- Antistatic spray (topical anti-stat) for floors

While it may not be practical to practice all the procedures outlined here, the more precautions taken, the better the chances of avoiding problems with static damage.

1-28 VPR-3 CAPABILITIES

Some standard features and capabilities of the basic VPR-3 include:

- Vacuum capstan, gas film, and roller guides provide gentle, precise control of tape in all operating modes, without use of a pinch-roller.
- Variable speed shuttle, providing up to 500 in/s (1270 cm/s) speed in forward and reverse (50X normal).
- No adjustment needed, whether reels are loaded with three hours of tape or with one minute of tape.
- Tape acceleration to 500 in/s in one second.
- Automatic scan tracking (AST*), allowing mechanical deflection of the video play head. This ensures accurate tracking of recorded video material throughout playback speed range. With the addition of the optional TBC-3, AST enables the VPR-3 to provide a broadcast-quality video signal in a continuously variable playback range from -1X normal (reverse motion), still frame, up to +3X normal speed. The TBC-3 provides a viewable picture in shuttle modes.
- Picture lockup in less than one TV field.
- Three audio channels, all capable of full bandwidth record and playback operation. A fourth audio channel is optional for VPR-3s operating in 625-line standards.
- Menus and multifunction soft keys.
- Auto edit control with tape timer. This feature provides complete automatic editing capability, including programmable entrance- and exit-edit points, as well as rehearsal preview and review features.
- Two tape timers provide digital display of tape time with one-frame accuracy.
- Animation capability.

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*Trademark, Ampex Corporation

- Video meter, permitting monitoring of off-tape rf level or incoming video level.
- Unique subcarrier-to-horizontal phase (ScHΦ) meter and control afford faster tape edits without picture shift.
- Automatic computer optimization of video and audio record parameters, with data storage to accommodate three tape types.
- Large dot-addressable fluorescent display with direct access and six menu-identified soft keys for organizing and displaying operational controls and diagnostic functions.
- Two SMPTE serial communications ports (RS-422).
- Audio I/O processing ports for interfacing with noise reduction and time compression expansion systems.

1-29 Additional Capabilities

Some features and capabilities available by adding optional equipment and accessories to the VPR-3 include:

- Color framer to minimize horizontal picture shift during editing or switching by providing synchronous start for full-color frame playback. The Color Framer PWA is available in NTSC, PAL-M, PAL, and SECAM versions.
- Time-code reader-generator/character-generator accessories to allow longitudinal time-code generation and reading on audio track 3, as well as displaying time code on a picture monitor. Vertical interval time code is also available.
- Line-by-line digital auto chroma which automatically adjusts playback equalization to provide improved multiple generation tape duplication. (Field-based auto chroma is standard.)
- A four-channel audio kit (available for 625-line only) which supplies a fourth audio channel on the track space otherwise allotted to the sync channel.
- Sync kit (for both 525-line and 625-line). This sync channel option permits recording of vertical interval information on a separate track. Both 525-line and 625-line versions are available.

1-30 Additional Capabilities with Accessory Equipment

The VPR-3 is designed for compatibility with standard Ampex audio/video system options and accessories such as the SMC-100 Slow Motion Controller which, when coupled with the VPR-3 via the SMC Serial Interface accessory, provides remote and expanded control of VTR transport functions including normal speed playback, variable forward slow motion, freeze frame, variable speed shuttling, and automatic cue point. It also includes two manually controllable cue points used in conjunction with the SMC-100 front panel 60-second clock display.

The VPR-3 can be integrated into the Ampex Computerized Editing System (ACE). The ACE central edit controller communicates with the on-line system components via SMPTE-proposed RS422-compatible lines (see Figure 1-1).

The TBC-3 Digital Time-Base Corrector gives a broadcast-quality video signal from the VPR-3 during normal playback, still-frame playback, and any of the continuously variable playback speeds from -1X to +3X normal playback without picture disturbances. It also affords a viewable picture in shuttle modes. During still-frame playback, a one-field still frame or the true two-field frame can be selected. Between speeds from -1/4X normal to +2X normal, single field or true frame can be selected; outside of those limits, only single-field playback is possible. The TBC-3 includes standard features such as the color-phased one-line dropout compensator to replace missing video information with video from the previous line, and the second-order velocity compensator that reduces time-base errors on a line-by-line basis.

1-31 PHYSICAL DESCRIPTION

Major assemblies that make up the VPR-3 are shown in Figure 1-2. The following paragraphs describe physical characteristics of each assembly.

1-32 Transport Assembly

The transport assembly (Figure 1-3) consists of a top plate and all tape handling and head subassemblies mounted on it. A hinged front cover provides access to the tape threading path and protects transport components. In Figure 1-3, the transport cover has been removed so that major transport subassemblies are visible.

1-33 Top Plate

The top plate is a ribbed aluminum alloy casting upon which the transport subassemblies are mounted. Subassemblies are attached with machine screws to precision-ground, threaded bosses on the top plate. All subassemblies, with the exception of capstan and air system subassemblies, are removable from the front side of the top plate.

1-34 Tape Handling Subassemblies

Subassemblies described in the following paragraphs move and guide the tape through the threading path.

1-35 Reel Motors and Turntable Assemblies. Reversible dc motors are used to drive supply and takeup reels. Tape reels are secured with hold-downs on the reel motor turntables. The VPR-3 is virtually indifferent to reel diameters. Its transport handles 14-inch, three-hour reels containing 9200 feet of tape and spot reels containing 15 or 30 seconds of tape with equal smoothness. VPR-3 reel hubs are designed with a high peripheral mass, and servo gains are set to anticipate static and dynamic inertia values of that mass. The value of the mass is great enough that additional inertia of the tape reels, large or small, is sensed only as a small difference in the anticipated mass. The result is smoother tape handling, regardless of reel diameter.

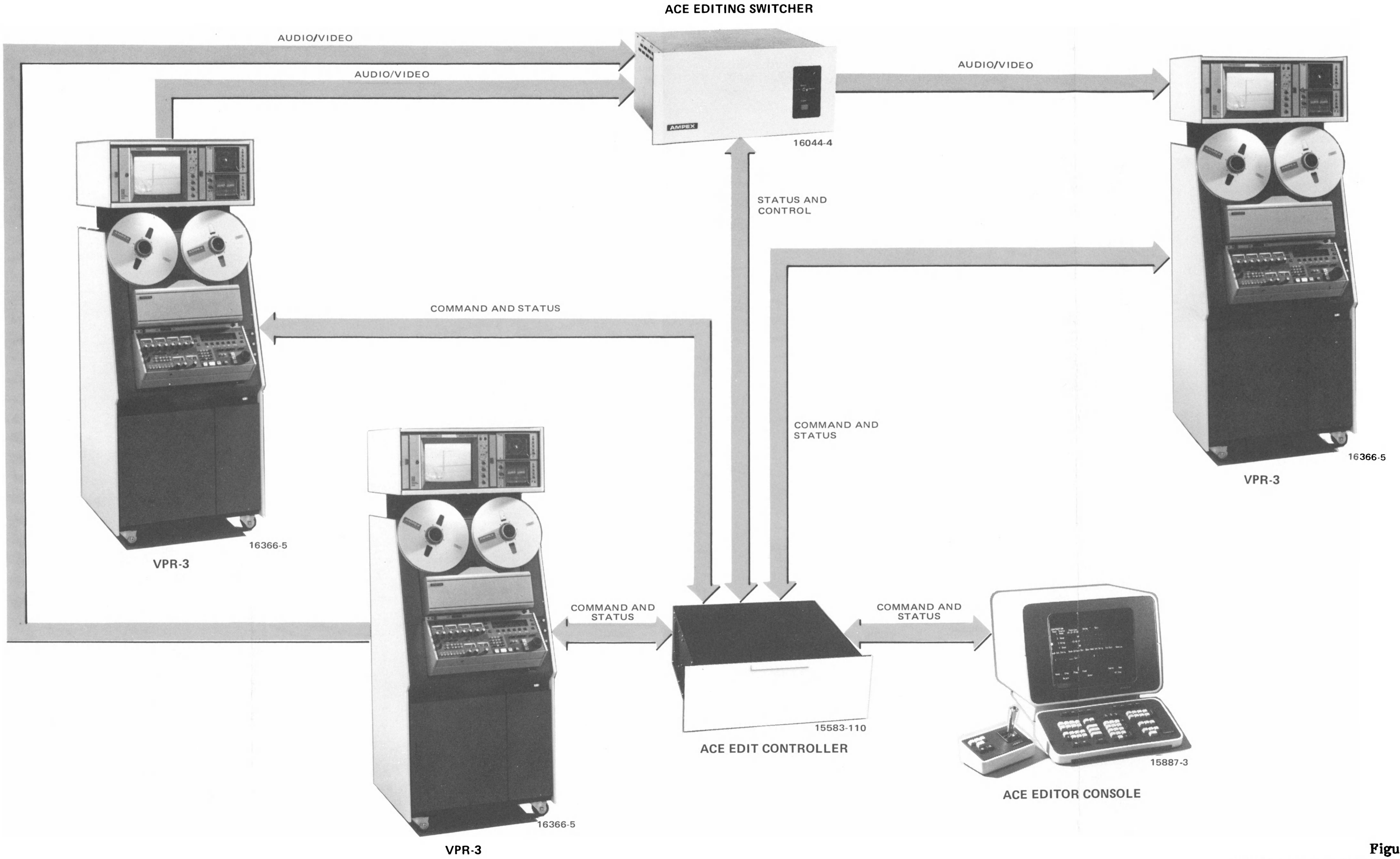


Figure 1-1.
Editing System Configurations

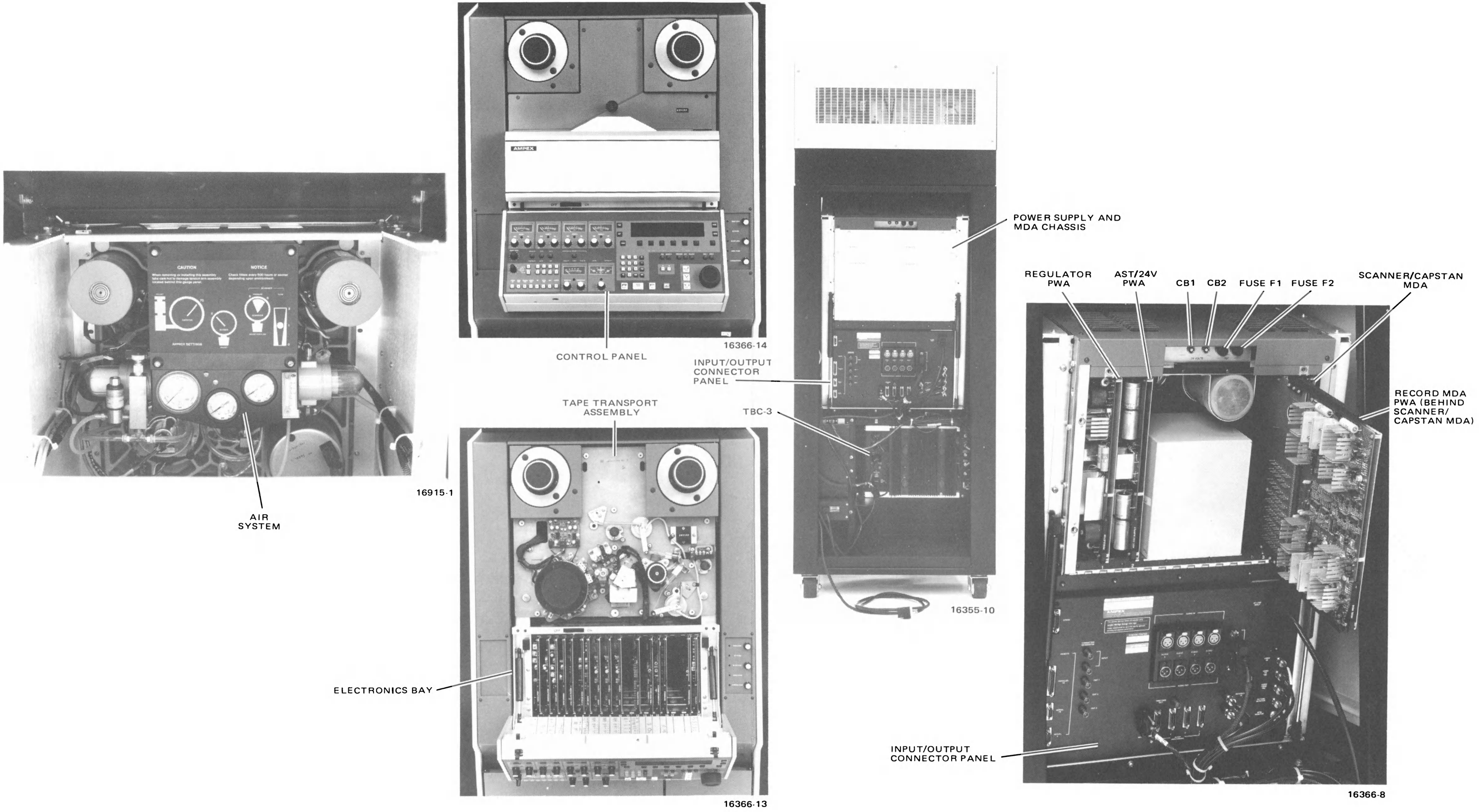


Figure 1-2.
VPR-3 Major Assemblies

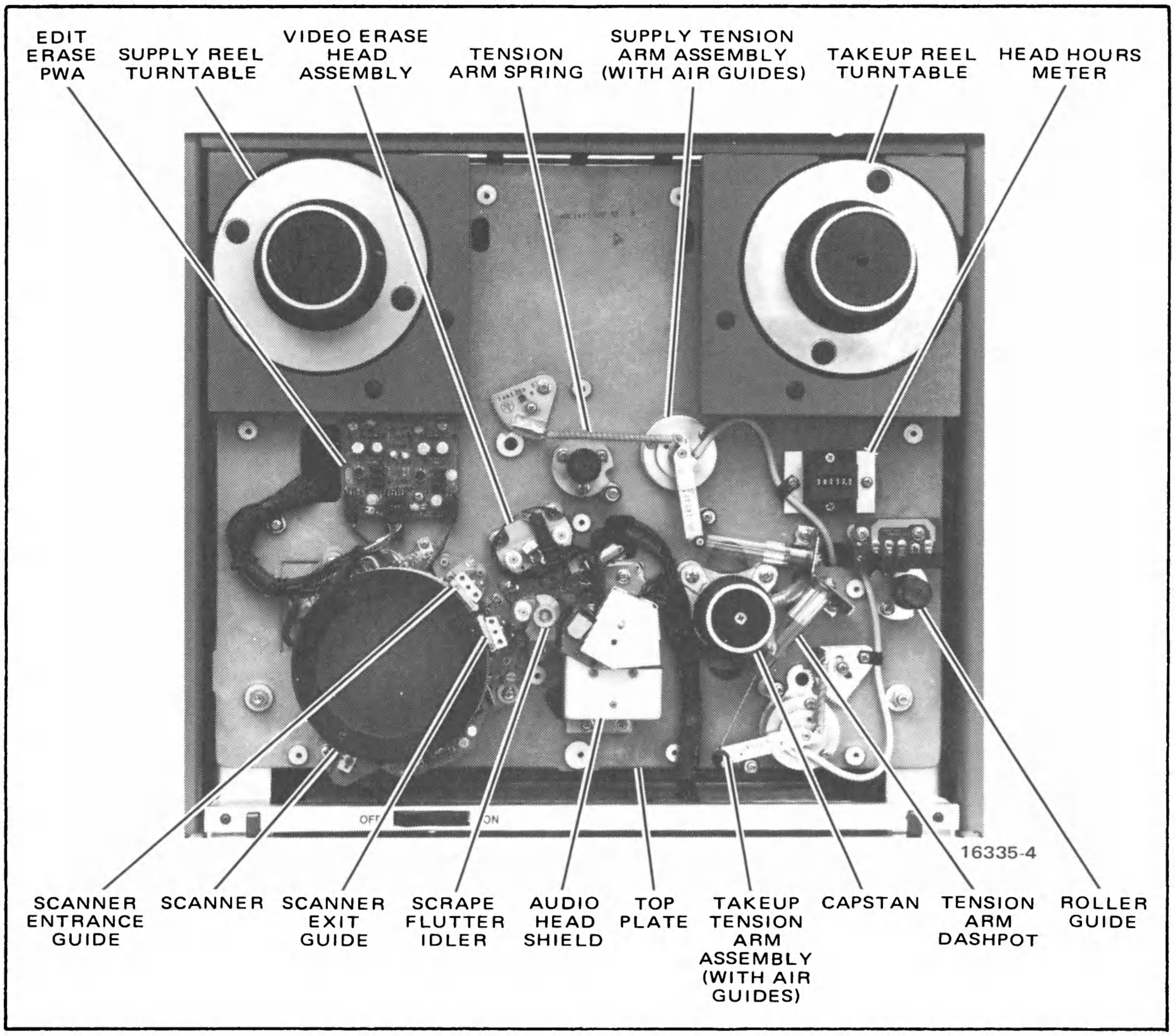


Figure 1-3. Transport Assembly

1-36 **Flutter Idler, Roller, and Air Guides.** Seven air guides are used in the VPR-3 transport assembly tape path. These air guides greatly reduce tape path friction, providing fast, gentle tape handling with predictable friction characteristics for all brands of tape. In each air guide, air is forced out of small holes that extend from the surface to an interior air chamber. Escaping air forms a thin film that cushions the tape from the guide surface, thus eliminating friction that would be present if the tape made contact with the guide.

Tape from the supply reel first passes over a rigidly mounted, large-diameter fixed guide which provides initial edge guiding. Tape then contacts an air-guide tension arm subassembly, which alters tape direction and senses tape tension from the supply reel. Next, the tape travels over a roller guide, a longitudinal video erase head, and a small diameter air guide. Entrance and exit air guides (part of the scanner assembly) provide proper positioning of the tape at the entrance to and the exit from the scanner guide band. Upon leaving the scanner, the tape passes over another air guide and then over a flutter idler. The flutter idler isolates video head tip disturbance from the audio head stack. After moving across the audio head stack, the tape is passed over an air guide and then held against the capstan by vacuum, which is present during all modes of operation. Tape leaving the capstan travels over an air guide tension arm subassembly, which alters tape direction and senses takeup reel tape tension. The tape then contacts a roller guide, which properly positions the tape to the takeup reel.

1-37 **Capstan.** The vacuum capstan, which is directly driven by a servoed dc motor, controls tape speed. An optical tachometer supplies capstan speed information for the servo. During record operations, the capstan determines track spacing. During playback, the capstan ensures accurate alignment of recorded tracks to the video head, with timing information being taken from the control track. Continuous capstan control of tape motion allows use of a coupling servo, which monitors both air guide tension arm subassemblies to regulate capstan acceleration in accordance with reel servo capabilities. As a result, the capstan optical tachometer replaces a separate tape timer tachometer assembly. The VPR-3 gives a selectable digital readout display of the tape timer position.

1-38 **Scanner.** Major scanner assembly components are a servo-controlled dc motor, a stationary lower drum, a rotating upper drum, and entrance and exit air guides. In accordance with Type C format specifications, the scanner has positions for six heads, including three active video heads (edit erase, record, and playback) spaced 120° apart, and three dummy heads. When the sync channel option is installed, dummy heads are replaced by sync channel erase, record, and playback heads. In either the sync or nonsync configuration, the video playback head is a special AST playback head. The scanner also contains rotary transformers to transfer signals between the rotary and stationary elements of the scanner assembly.

1-39 **Longitudinal Heads.** Two longitudinal head subassemblies are mounted on the transport assembly (refer to Figure 1-3). The top subassembly is the video erase head. The lower subassembly consists of three head stacks:

- The first stack consists of erase heads for each of the audio channels and a head for control track erase.
- The second stack has record/playback heads for each of the audio channels and another record/playback head for the control track.
- The third stack has heads for the control track and each audio channel confidence function.

1-40 Control Panel Assembly

Primary operating controls, indicators, and a display screen are located on the VPR-3 control panel assembly. This control panel is divided into six functional sections:

- Display controls, soft keys, and keypad
- Mode enable control

- Transport speed controls
- Video I/O level controls and metering
- Audio I/O level controls and metering
- Audio/video monitor controls

1-41 Electronics Bay

The electronics bay located behind the VPR control panel assembly consists of a motherboard/wiring assembly with slots for up to 20 PWAs. Secondary operating controls and indicators as well as test points are located on the PWA front edges. The VPR control panel assembly is hinged, allowing it to be swung down to provide access to these PWAs. Table 1-6 lists PWA complement.

Table 1-6. Electronics Bay PWA Complement

Slot No.	PWA Name
1	Modulator
2	Demodulator
3	Equalizer (sync option) Equalizer (nonsync option)
4	Auto Chroma (accessory)
5	Color Framer
6	Playback Sync
7	AST Servo
8	Audio 1
9	Audio 2
10	Audio 3
11	Audio 4 (Accessory)
12	Audio Control
13	Spare
14	Reel/Scanner Servo
15	Control Track/Capstan Servo
16	Reference Generator and Tape Remaining
17	Spare
18	Time-Code Reader/Character Generator (Accessory)
19	None
20	Control

1-42 Power Supply and MDA Assembly

The power supply bay contains a motherboard/wiring assembly, a power supply, and four PWAs. The four PWAs are: Regulator PWA, AST/24V Supply PWA, Reel Motor Drive Assembly (MDA) PWA, and Capstan/Scanner MDA PWA. The power supply contains a transformer, rectifiers, and capacitors. The power supply and regulator PWA provide voltages required for VPR operation. Drive voltages for all motors (reel, capstan, and scanner) on the tape transport are provided by the two MDA PWAs. The AST/24V Supply PWA provides drive voltages to the AST head in response to signals from the AST Servo PWA.

1-43 Air System

The air system is housed in an acoustically shielded enclosure located behind the tape transport, and provides air used by the air guides on the tape transport, and vacuum required by the capstan. It also supplies air for the air-actuated audio headstack shield that slides into position when VPR-3 power is on and tape is threaded. An ac-powered rotary-vane type compressor produces the pressure. Two pressure regulators, one for the scanner guides and the other for the transport guides, reduce pressure to specification. A pressure regulator in the vacuum line is used to adjust the capstan vacuum. The system uses two air filters. One filters the air drawn in through the capstan, and the other filters the air output to the guides.

1-44 Fan Assembly

The fan assembly mounted on top of the power supply bay provides cooling air for internal VPR-3 components, and consists of a mounting panel, two circuit breakers, two fuses, and two fans.

1-45 Connector Panel Assembly

The connector panel assembly is located on the rear of the VPR, and contains all VPR input and output connectors required for local and remote operations.

1-46 STANDARD EQUIPMENT

Table 1-7 is a list of equipment supplied with the basic VPR-3.

Table 1-7. Standard Equipment Supplied

Basic VPR-3, consisting of:	
Basic Assembly	Electronics Bay*
Rack Assembly	Frame Trim Assembly
Transport Assembly	Miscellaneous Parts Kit
Frame Assembly	Power Supply PWA Extender
Control Panel Assembly	Scanner Assembly
Power Supply Bay	
* See Table 1-6 for PWA names.	

1-47 SPECIFICATIONS

Specifications for the VPR-3 are given in Table 1-8. Dimensions of the VPR-3 in various mounting configurations are shown in Figure 1-4. Ampex reserves the right to make product and specification changes at any time without notice.

Table 1-8. VPR-3 Specifications

Characteristics	PAL/SECAM 625/50	NTSC/PAL-M 525/60
Video and Sync		
Bandwidth	flat to 5.0 MHz ±0.5 dB -3 dB at 6.0 MHz	flat to 4.2 MHz ±0.5 dB -3 dB at 5.0 MHz
Signal-to-noise (Rohde and Schwarz unweighted with bandpass filter) using TBC-3	-44 dB p-p video to RMS noise on interchange basis	-47 dB p-p video to RMS noise on interchange basis
LF linearity	2% blanking to white maximum	2% blanking to white maximum
Differential gain	4% blanking to white maximum	4% blanking to white maximum
Differential phase (40 IEEE units of subcarrier through TBC-3)	4° at 4.43 MHz off-tape maximum	4° at 3.58 MHz off-tape maximum
Chrominance/Luminance Delay	25 ns max	20 ns maximum
2T sin^2 pulse and bar	1% K-factor maximum	1% K-factor maximum
Moiré	-36 dB color bars 75% amplitude 4.43 MHz subcarrier	-40 dB color bars 75% amplitude 3.58 MHz subcarrier
Audio (CH 1, 2, and 3)		
Frequency response (400 Hz ref) 100 nWb/m reference level	±1 dB 200 Hz to 12 kHz ±2 dB 50 Hz to 18 kHz	±1 dB 200 Hz to 12 kHz ±2 dB 50 Hz to 18 kHz
Signal-to-noise (with respect to +8 dB above reference level) 20 Hz to 20 kHz	-56 dB audio 1 and 2, -54 dB for Audio 3(1)	-56 dB audio 1 and 2, -54 dB for audio 3(1)
Distortion (measured at 1 kHz)(3 HD)		

(Continued next page)

Table 1-8. VPR-3 Specifications (Continued)

Characteristics	PAL/SECAM 625/50	NTSC/PAL-M 525/60
Audio (CH 1, 2, and 3) (Continued)		
@ 100 nWb/m reference	1% max	1% max
@ 251 nWb/m peak level	3% max	3% max
Predistortion at 200 nWb/m (+14 dBm)	1% max	1% max
Depth of erasure on its own recording	-70 dB	-70 dB
Wow and flutter	0.07% DIN weighted (R/P)	0.07% NAB unweighted (flutter tape)
Playback crosstalk (audio 1 and 2) 1 kHz referenced to +8 dBm or 100 nWb/m	-60 dB max	-60 dB max
General		
Record time	190 min nominal; 9200 ft of tape	190 min nominal; 9200 ft of tape
Shuttle time	less than 72s for 60-min tape, 3.6 min for a 3-hr tape.	less than 72s for 60-min tape, 3.6 min for a 3-hr tape.
Tape timer accuracy (control track updated)	±0.1 field with continuous control track	±0.1 field with continuous control track
Tape speed	239.8 ±0.5 mm/s; 9.44 ±0.02 in/s	244 ±0.5 mm/s; 9.606 ±0.02 in/s;
Video writing speed	842 in/s nominal	1009 in/s nominal
FM carrier frequencies	7.68 MHz blanking, 8.9 MHz peak white	7.9 MHz blanking 10.0 MHz peak white
Audio equalization (time constants)	15 µs 3180 µs	15 µs

(Continued next page)

Table 1-8. VPR-3 Specifications (Continued)

Characteristics	PAL/SECAM 625/50	NTSC/PAL-M 525/60
General (Continued)		
Lock-up time from ready mode	20 ms	20 ms
Signal Inputs		
Video input (75Ω BNC)	0.5V to 2 Vp-p	0.5V to 2 Vp-p
Ref video (75Ω BNC)		
Comp video	0.5V to 2V	0.5V to 2V
Comp sync	0.7V to 4V	0.7V to 4V
Audio line inputs	-24 dBm to +24 dBm, +8 dBm nominal	-24 dBm to +24 dBm, +8 dBm nominal
Impedance, transformerless, true differential	balanced; 65 KΩ resistive	balanced; 65 KΩ resistive
Signal Outputs		
Video output (75Ω) BNC	1.0 Vp-p	1.0 Vp-p
Audio line output, transformerless, true differential	+8 dBm nominal; balanced +24 dBm max(2)	+8 dBm nominal; balanced +24 dBm. max(2)
Impedance	less than 20Ω	less than 20Ω
Headphone audio monitor	0 dBm to drive 600Ω	0 dBm to drive 600Ω
Power Input		
Power line frequency	50 Hz, single phase	60 Hz, single phase
Input voltages	190/210/230/250/270/ Vac, ±5%	95/105/115/125/135 Vac, ±5%
Input current (table top)	230 Vac, nominal 1.8A**	115 Vac, nominal 3.5A*

(Continued next page)

Table 1-8. VPR-3 Specifications (Continued)

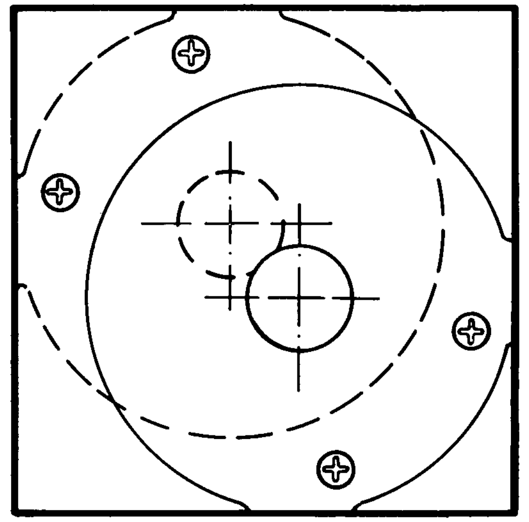
Characteristics	PAL/SECAM 625/50	NTSC/PAL-M 525/60
Power Input (Continued)		
Input current (lowboy console TBC and color monitor bridge)	230 Vac, nominal 3.5A**	115 Vac, nominal 7.0A*
Temperature and Humidity		
Temperature	0° C to 45° C	0° C to 45° C
Humidity	10% to 90% RH (noncondensing)	10% to 90% RH (noncondensing)

* Additional 12A, 1s shuttle start surge
**Additional 6A, 1s shuttle start surge

(1) Audio 3 channel has wide-band capability for time code (S/N WB-30 dB)
(2) Can be readjusted downward by 12 dBm.

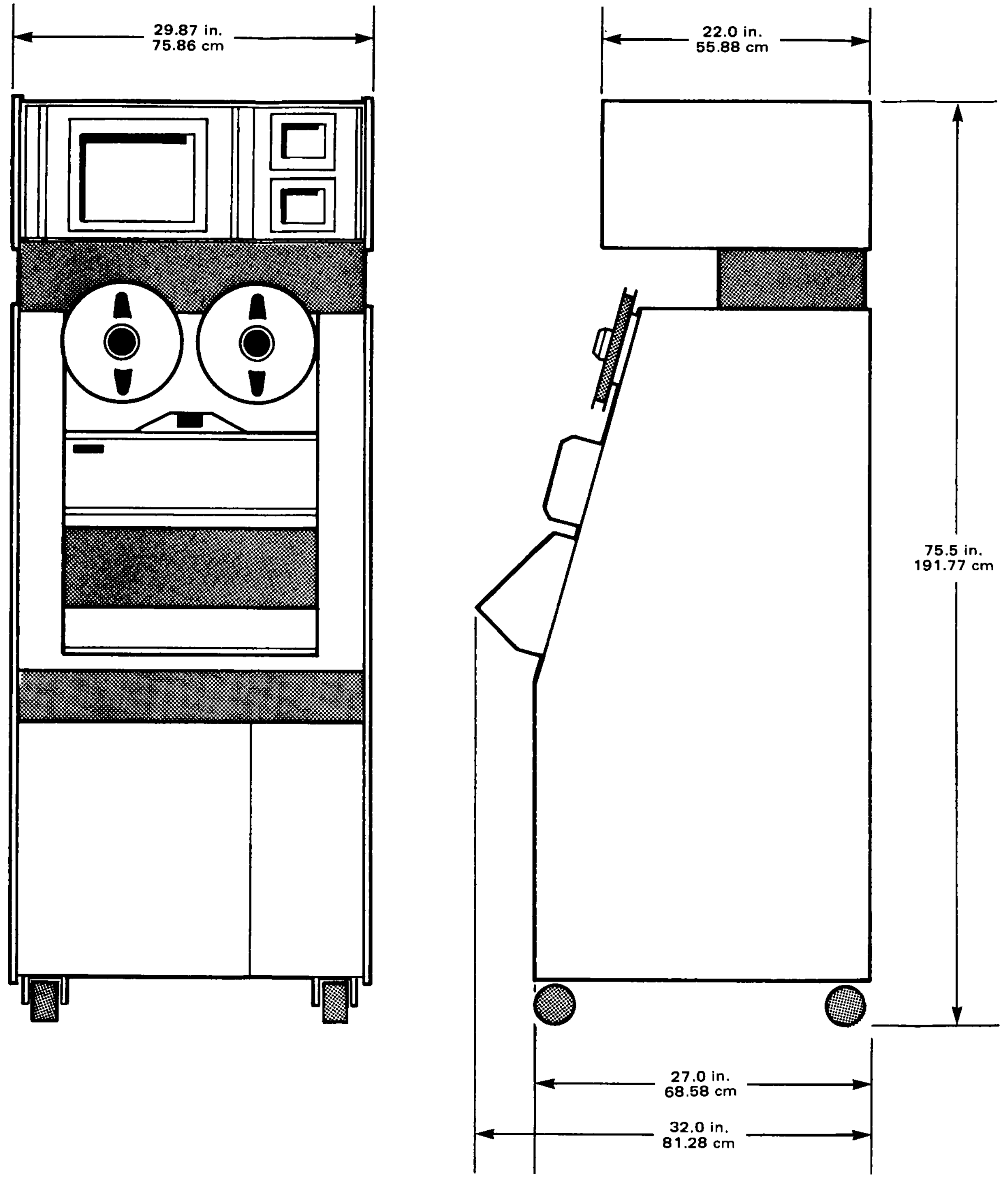
SELECTABLE REEL SIZE

The reel motors have a unique mounting base which allows motor position to be changed. In the outer position, 3-hour 14-in. reels are accommodated. The inner position, which permits mounting VPR-3 in a 19-in. rack, has a 2-hour or 11-3/4-in. maximum reel size. Modification of a standard 19-in. rack will allow use of the 3-hour position.



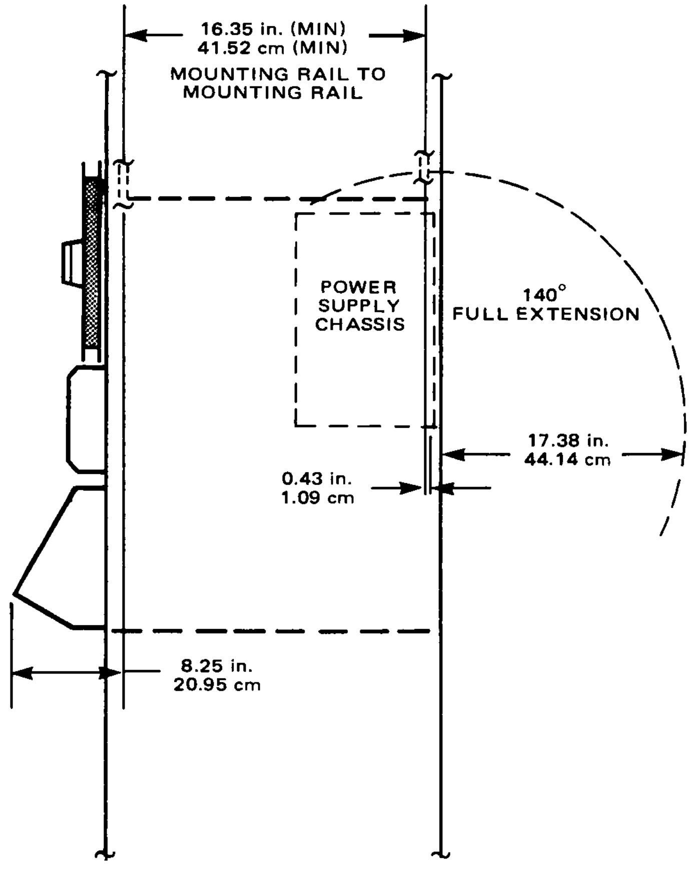
CONSOLE

The optional console has provisions for mounting the VPR-3, TBC-3, a picture monitor, waveform and vector monitors, and the high-power audio system.



RACK MOUNT

19-in. RACK COMPATIBLE



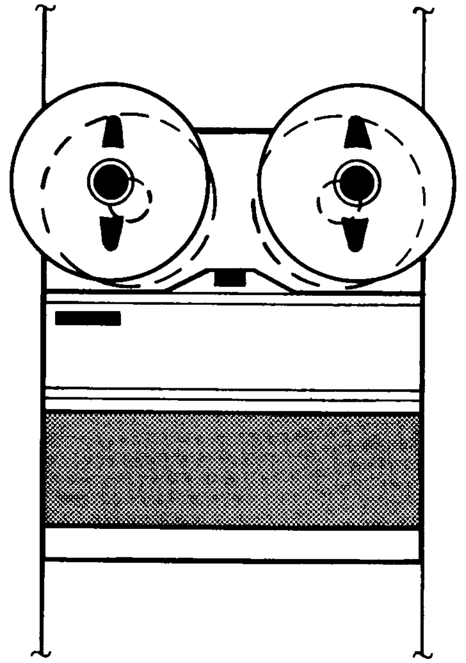
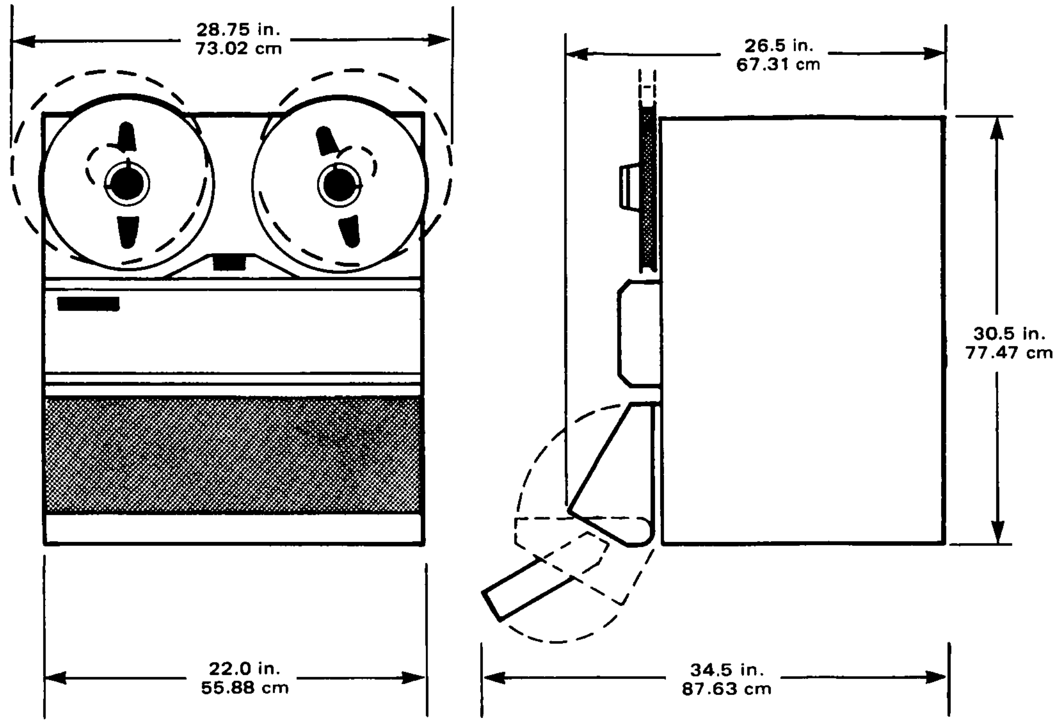


TABLE TOP



Physical Dimensions	Console with Monitor Bridge and TBC	Rack Mount	Table Top
Height	75.5 in. (191.77 cm)	29.75 in. (75.56 cm)	30.5 in (77.47 cm)
Width	29.875 in. (75.86 cm)	19.0 in* (48.26 cm)	22.0 in. (55.88 cm)
Depth	32.00 in.** (81.28 cm)	25.75 in. (65.4 cm)	26.5 in. (67.31 cm)
Weight	650 lb (294.84 kg)	270 lb (122.47 kg)	275 lb (124.74 kg)

* + 2-in. front mounting trim and control panel.
**Removable control panel reduces depth to 27 in.

Figure 1-4.
VPR-3 Specifications

SECTION 2
OVERALL SYSTEM OPERATION

2-1 INTRODUCTION

This section describes functional operation of the VPR-3 Video Production Recorder. System and subsystem block diagrams, and an overview of the Type C format for which the VPR-3 is designed, are included. See the *VPR-3 Parts Lists and Schematics* manual, Catalog No. 1809608, for related schematic diagrams.

2-2 TYPE C FORMAT

The SMPTE and EBU Type C format for one-inch helical video tape recording exists to ensure compatibility (interchange) among tapes recorded by—and played back on—different video tape recorders, including those of different manufacturers. Type C format is a nonsegmented format in which one rotation of the scanner (or head drum) records one field of television video.

The SMPTE and EBU Type C format provides specifications covering such operational considerations as:

- Placement and orientation of record tracks on tape.
- Scanner, transport, and guiding geometry required to produce record tracks.
- Electronics specifications, including parameters for audio, video, control track, and sync track signals.

2-3 Record Tracks

Figure 2-1 shows a tape section viewed from the oxide side. By making record tracks visible, this drawing shows track locations for helical (angled) and longitudinal tracks. Longitudinal tracks (those parallel with tape edge) are recorded by heads on the stationary audio head stack. Helical video and sync tracks are recorded by heads on the rotating scanner, upper portion of scanner assembly. Record track layout is the same for both NTSC and PAL Type C Format versions. However, helical track angle and length, and certain other record track dimensions, differ somewhat due to different tape and scanner rotation speeds.

2-4 Format Options

Figure 2-1 shows three format options affecting record tracks near the tape's bottom edge. The basic option (I) has no sync track; information occurring during vertical interval dropout time is lost, and cannot be recorded or played back. With the sync track option (II), information occurring during vertical interval dropout time is recorded/played back by sync track heads.

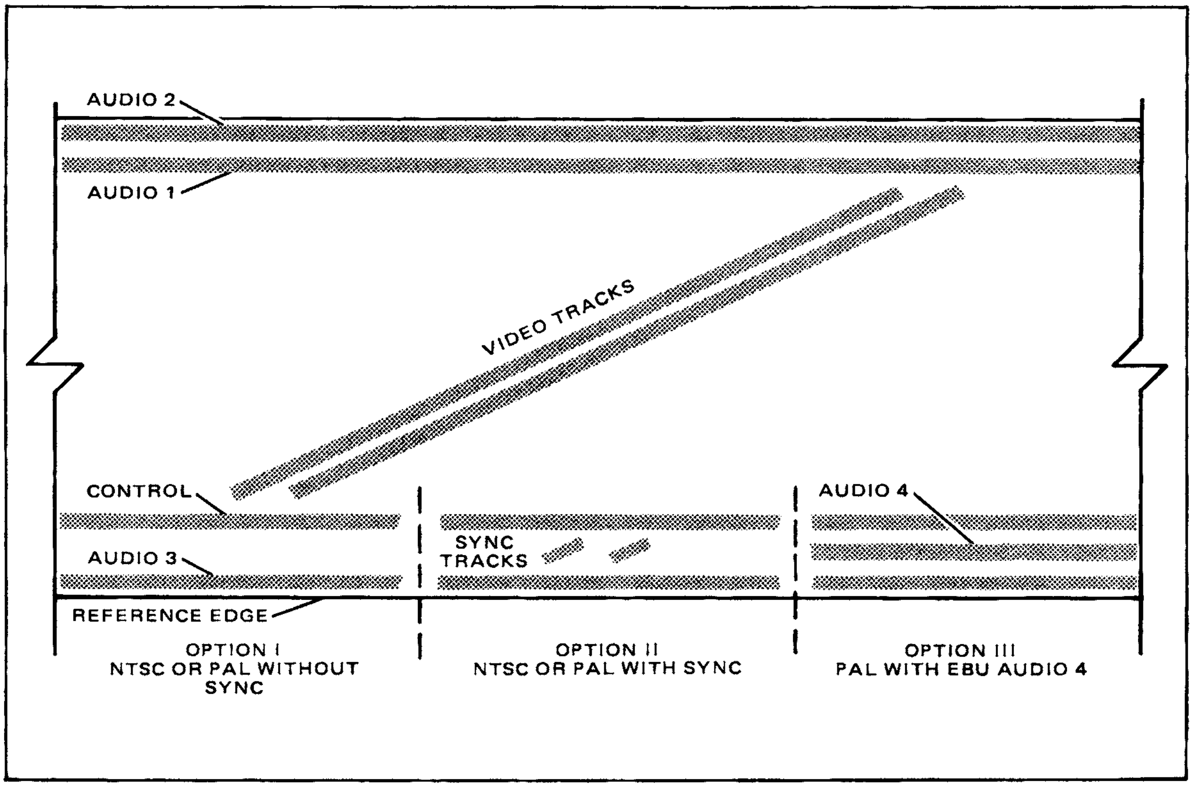


Figure 2-1. Type C Format Options

Option III allows PAL/SECAM machines equipped for EBU audio 4 to record the fourth audio track in the tape area normally reserved for sync track.

2-5 Control Track. Different television recording formats use different schemes for recording control track. The SMPTE C format records a saturated control track which has a square-wave fundamental. The EBU C format uses a biased-pulse signal. The latter method uses less energy, and eliminates the low frequencies associated with a saturated signal. This results in less cross talk into adjacent channels, and makes the addition of a high-quality audio 4 track (in place of sync track) practical.

2-6 Audio 3. The audio 3 track, standard with the Type C Format, is normally used for time code or cueing. However, since track width is the same as that on audio 1 and audio 2, the audio 3 track has the capability of a high-quality audio track.

2-7 Scanner. Figure 2-2 provides two views of the scanner portion of the scanner assembly (called upper drum by Type C format test). The scanner rotates in a clockwise direction, while the tape travels around the scanner in a counterclockwise direction (as viewed from the front of the machine). The tape elevates as it travels around the scanner (by guides—not shown), an action which allows for helical tracks laid down by scanner heads that pass across the tape at an angle.

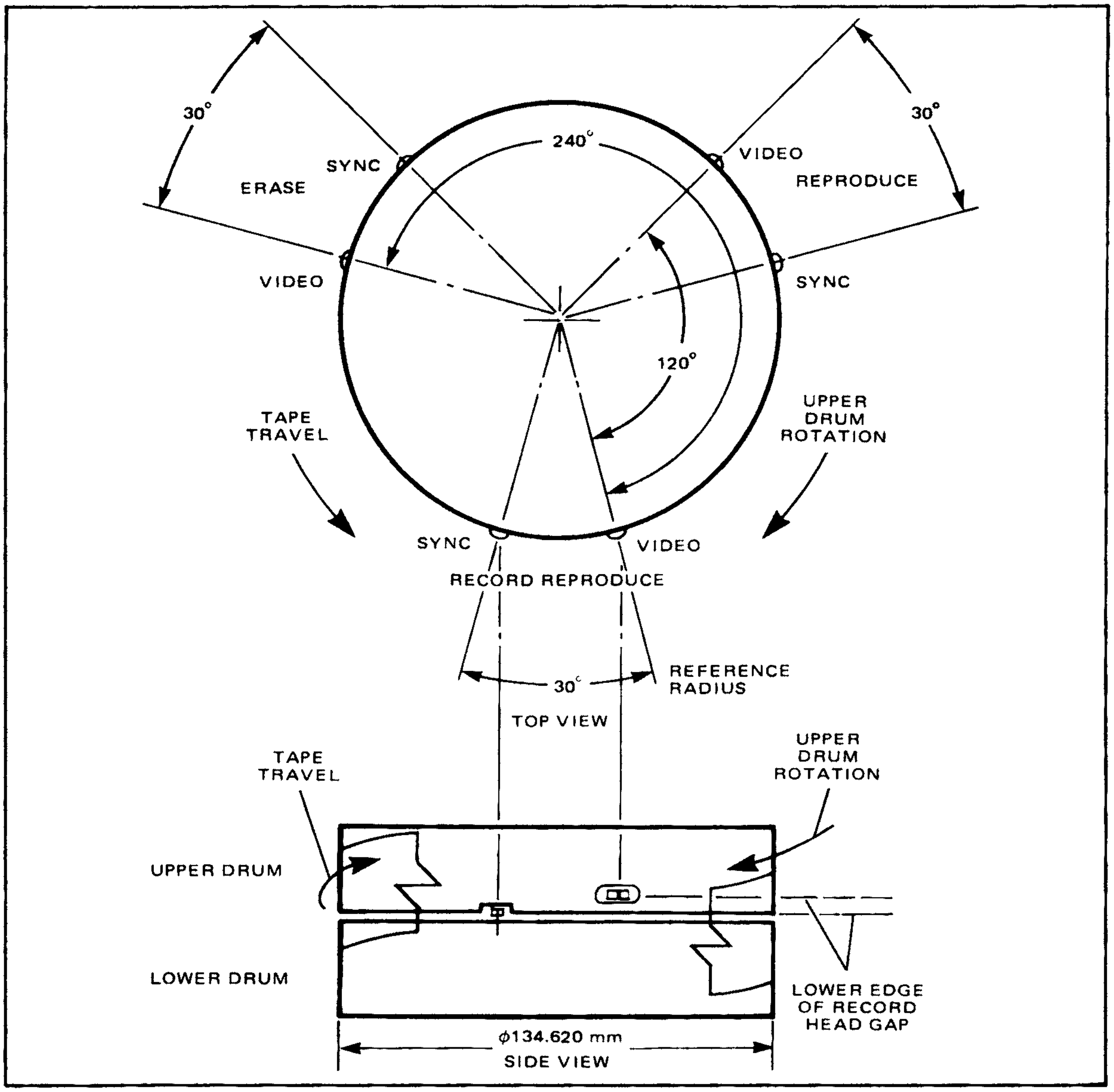


Figure 2-2. Scanner

2-8 **Vertical Interval Dropout.** Because the tape wrap around the scanner is less than 360°, a period of scanner rotation occurs during which the video head does not contact the tape, as shown in Figure 2-3. This is the vertical interval dropout period. Information which would otherwise be lost during this period can be recorded/played back by optional sync heads.

2-9 OVERALL SYSTEM OPERATION

Figure 2-4 is an overall VPR-3 system block diagram, and each block represents a functional VPR-3 subsystem. Theory of operation of each subsystem is described in the following paragraphs.

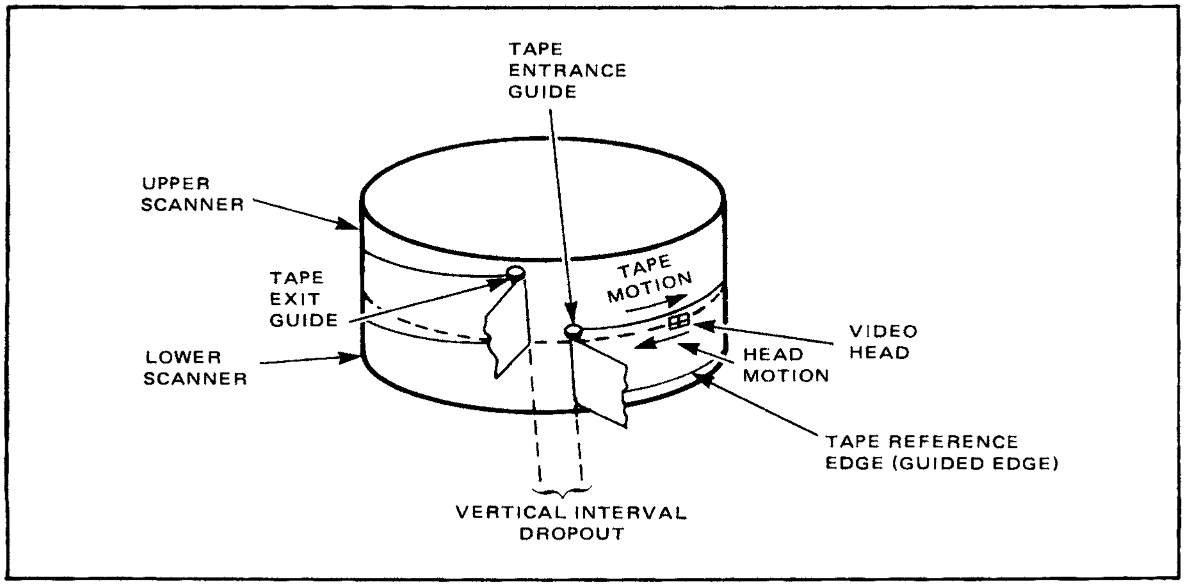


Figure 2-3. Vertical Interval Dropout

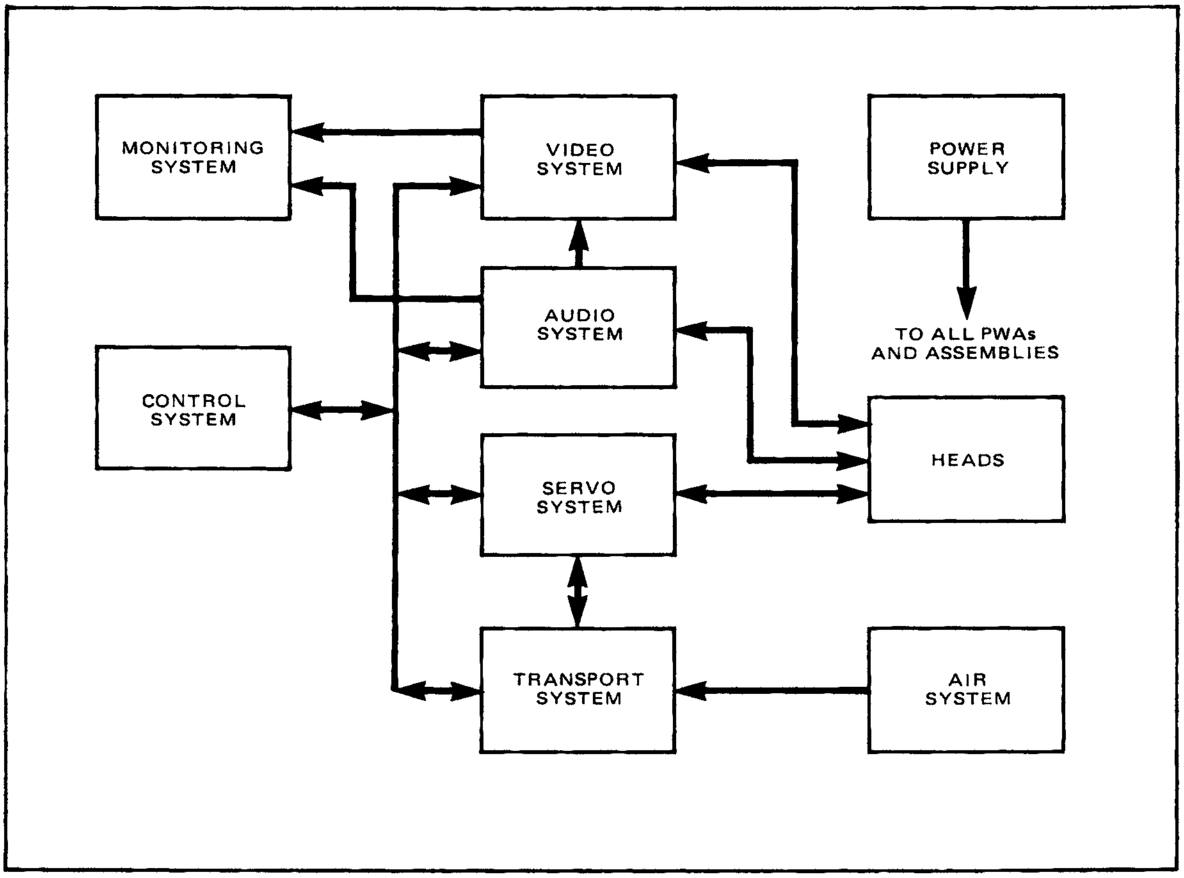


Figure 2-4. VPR-3 Overall System Block Diagram

2-10 Video System

The video system provides signal processing required for recording, playing back, and monitoring a composite video signal. A separate sync channel can be recorded and played back if the optional sync kit is installed. In record mode, composite video signal from a camera, VTR, or other source modulates an rf signal which drives the record head. In play mode, the reverse occurs, where rf from the play head is demodulated and otherwise processed into appropriate video for studio use (via time-base corrector) and monitor operation. A block diagram of the video system is shown in Figure 2-5.

2-11 Modulator PWA

The Modulator PWA occupies electronics bay slot 1. The main function of this PWA is to generate a carrier frequency and frequency-modulate it with the incoming video signal for recording on tape. This PWA also provides variable-gain amplification of the input video for record level control, and a cable equalizer circuit that provides jumper-selectable control of equalization. In addition, it is the switching point for all VPR-3 system-generated video that can be selected for viewing on the waveform and picture monitors; as such, all monitorable video from the VPR-3 enters this PWA.

2-12 Demodulator PWA

The Demodulator PWA occupies electronics bay slot 2. This PWA demodulates and amplifies one of two incoming rf signals: either off-tape (playback) rf from the equalizer, or electronics-to-electronics (E-E) rf from the modulator. Demodulated video is applied to the Modulator PWA, where it can be routed through switches to the VIDEO OUT connector on the VPR-3's rear connector panel.

Standard field-rate auto chroma circuitry is located on the Demodulator PWA. This circuitry generates an error signal (AUTO CHROMA ERROR), which is sent to the Equalizer PWA.

2-13 Equalizer PWA

The Equalizer PWA occupies electronics bay slot 3. It equalizes rf signals sent from the video and sync play heads, removing distortion caused by the record/playback process, and routes signals to the Demodulator PWA and the AST Servo. Logic is provided to allow the auto chroma error to control equalization. In addition, this PWA functions as the switching point for various system-generated waveforms that can be selected for viewing on the waveform monitor; control signals supplied by the Audio Control PWA switch the selected waveform to the waveform monitor.

2-14 Record Amplifier PWA

The Record Amplifier PWA plugs into the lower portion of the scanner assembly. In record mode, this PWA amplifies the rf signal from the modulator, then directs this signal to the video record head (and sync record head, if so equipped). During edit play mode, an rf signal is received from the video record head, amplified, then directed to the equalizer. Two versions of this PWA exist to accommodate both sync option and standard VPR-3 models.

2-15 Video Preamp PWA

The Video Preamp PWA is mounted on the upper (rotating) portion of the scanner assembly. This PWA contains two preamplification channels, one for the video play head rf signal, the other for the sync play head (if so equipped). Play head signals are amplified and routed to the Equalizer PWA.

2-16 Edit Erase PWA

The Edit Erase PWA is mounted on the tape transport. This PWA provides edit erase oscillator current to the video edit erase and sync edit erase heads in the upper portion of the scanner.

2-17 Auto Chroma PWA

The Auto Chroma PWA (optional) enhances standard field rate auto chroma circuitry by providing line-by-line chrominance correction of the playback signal. Chroma errors are corrected on a line-by-line basis within a field, providing better-quality multiple generation tape duplication. The line-by-line equalization control signal is applied to the Equalizer PWA.

2-18 Color Framer PWA

During editing, the Color Framer PWA compares color phase and frame of the playback video and input video to aid in producing color-framed and shift-free edits. It measures the subcarrier phase relative to sync of either off-tape video or input video. The measured phase is indicated on the ScHϕ meter. In playback, the color framer assures that off-tape video frames match reference video frames. In addition, it determines the transport's precise parking location by identifying the exact field on which the tape is stopped. Parked frame information is provided for display panel readout.

2-19 Audio System

The VPR-3 audio system (see Figure 2-6) provides signal processing necessary for recording, playing back, and monitoring up to four audio channels. Record parameters (equalization, predistortion, bias, and record current level) for each channel can be set manually or automatically.

During automatic optimization, the VPR-3 incrementally varies record parameter values while generating a test frequency. The Audio PWAs respond with feedback information, allowing the system to determine optimum record values. These values are then transmitted back to the Audio Control PWA, where they are digitized and stored in memory. Optimized record parameters are read from memory and sent to individual Audio PWAs.

Each Audio PWA receives incoming audio signals from either an external source or the playback head, as well as control and setup information from the Audio Control PWA. Data from the Audio Control PWA is decoded to provide record parameter values and control signals necessary to optimize incoming audio signals.

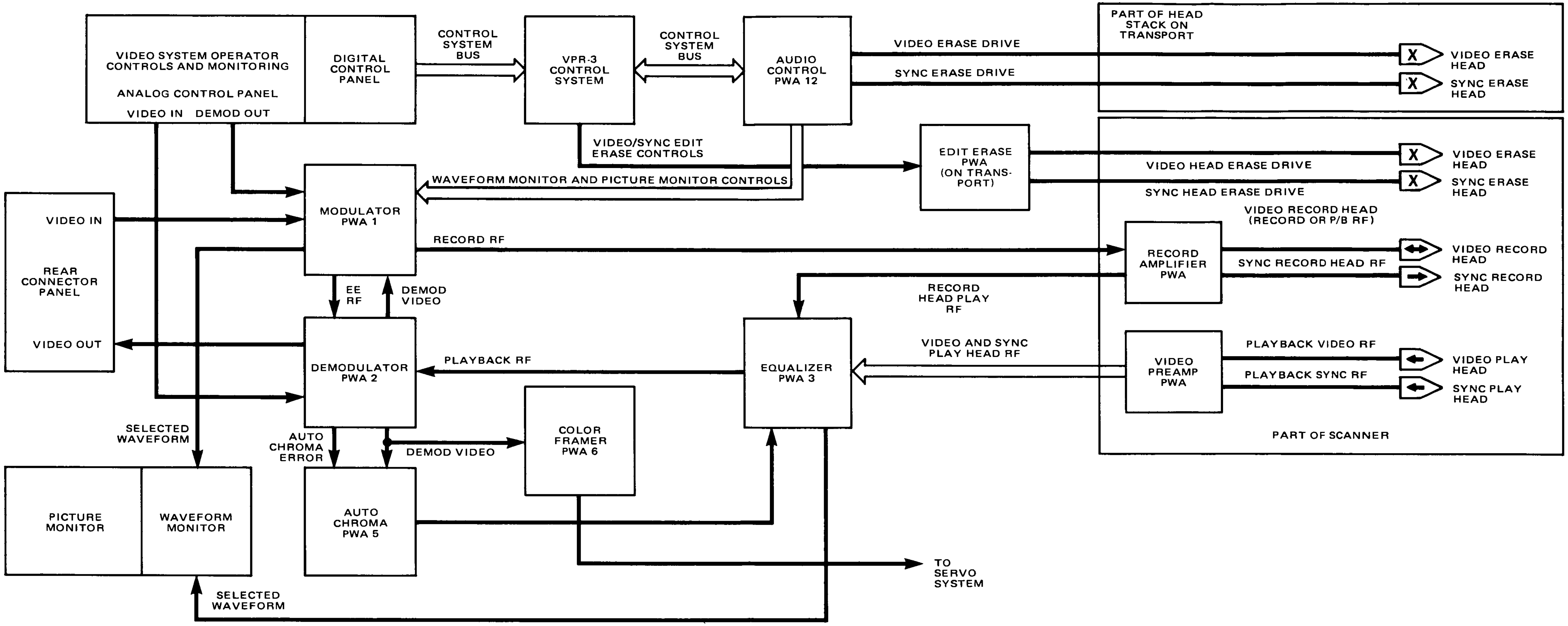


Figure 2-5.
Video Signal System Block Diagram

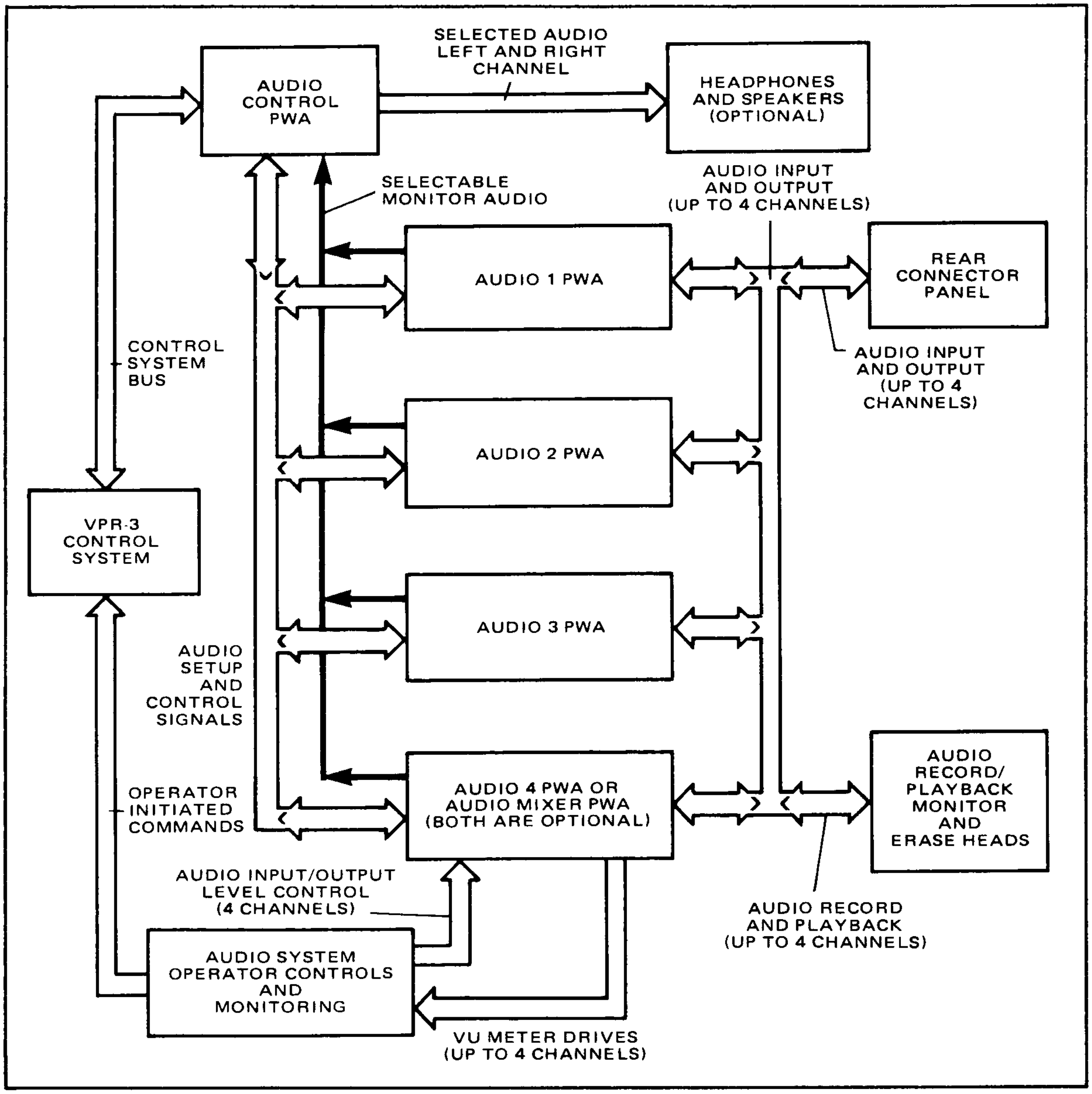

SELECTED AUDIO LEFT AND RIGHT CHANNEL
AUDIO CONTROL PWA
HEADPHONES AND SPEAKERS (OPTIONAL)
SELECTABLE MONITOR AUDIO
AUDIO INPUT AND OUTPUT (UP TO 4 CHANNELS)
AUDIO 1 PWA
REAR CONNECTOR PANEL
CONTROL SYSTEM BUS
AUDIO INPUT AND OUTPUT (UP TO 4 CHANNELS)
AUDIO 2 PWA
VPR-3 CONTROL SYSTEM
AUDIO 3 PWA
AUDIO SETUP AND CONTROL SIGNALS
OPERATOR INITIATED COMMANDS
AUDIO 4 PWA OR AUDIO MIXER PWA (BOTH ARE OPTIONAL)
AUDIO RECORD/ PLAYBACK MONITOR AND ERASE HEADS
AUDIO INPUT/OUTPUT LEVEL CONTROL (4 CHANNELS)
AUDIO RECORD AND PLAYBACK (UP TO 4 CHANNELS)
AUDIO SYSTEM OPERATOR CONTROLS AND MONITORING
VU METER DRIVES (UP TO 4 CHANNELS)

Figure 2-6. Audio System Block Diagram

Incoming audio passes through a transformerless differential input, and is routed to record signal processing circuitry. The signal is optimized using decoded record parameter values, and sent to the record head.

During playback, playback signal processing circuitry receives the incoming signal from the playback head. The processed signal is sent either to the output circuitry for transmission to both an audio output port and the control panel, or to the audio processor port. The audio processor port allows the processed signal to be interfaced with external noise reduction or time-compression/expansion equipment. This PWA also contains monitor and erase head circuitry.

2-20 Audio PWA 8—11

Audio PWAs occupy slots 8 through 11 in the VPR-3 electronics bay corresponding to audio channels 1 through 4, respectively. Audio channel 4, an option available for use with 625-line systems, is used in place of the sync channel. Each of these identical PWAs contains the circuitry required to receive and process one channel of audio.

2-21 Audio Control PWA

The Audio Control PWA interfaces the VPR-3's control system to the audio system. The Audio Control PWA receives audio system setup and control commands provided by the control system, and distributes them throughout the audio system. During automatic setup of the audio system, the Audio Control PWA continually monitors off-tape audio level in the channel being set up, digitizes the measured level, and provides this data to the control system. Potentiometer controls for equalization, predistortion, bias-level, and record-level parameters in the system's audio channels (up to four) are located on the front edge of this PWA; when manual control of the audio system is selected, these control settings provide reference voltages which are digitized and sent to the appropriate Audio PWA to control parameters. This PWA also generates an audio test tone used during automatic audio setup, provides erase currents to erase heads for erasure of the control, video, and sync tracks, and provides drive for headset and console speakers. In addition, some video system control is exercised by this PWA.

2-22 Control Systems

The control system (see Figure 2-6) consists of the control panel assembly and the Control PWA located in electronics bay slot 20. Controls and indicators on the front panel allow the operator to control and monitor VPR-3 operation. Whenever an operational mode (such as play, record, jog, etc.) is selected, the control system sends out sequenced commands to the VPR-3 subsystems, and guides the machine through a smooth mode transition. The control system also monitors system status signals, such as power supply voltage, condition of air system, presence of tape on the transport, etc., to provide warnings to the operator and to ensure fail-safe operation. It also stores data required for automatic setup of the audio system, and contains diagnostic routines for automatic system checkout and fault isolation. In addition, the control system generates output control data and receives input data to interface the VPR-3 to external auxiliary equipment.

2-23 Control Panel Assembly

The control panel assembly includes five PWAs: Input/Output PWA, Controls PWA, LED PWA, Switch Control PWA, and Meter Lamp PWA. These PWAs comprise various panel controls, indicators, and support electronics required to provide data to the Control PWA in the electronics bay.

2-24 Control PWA

The Control PWA contains two microprocessors, a stored program, and support electronics (see Figure 2-7). One microprocessor is used for system control. It controls the digital control panel, the servo system, the audio system, the time-

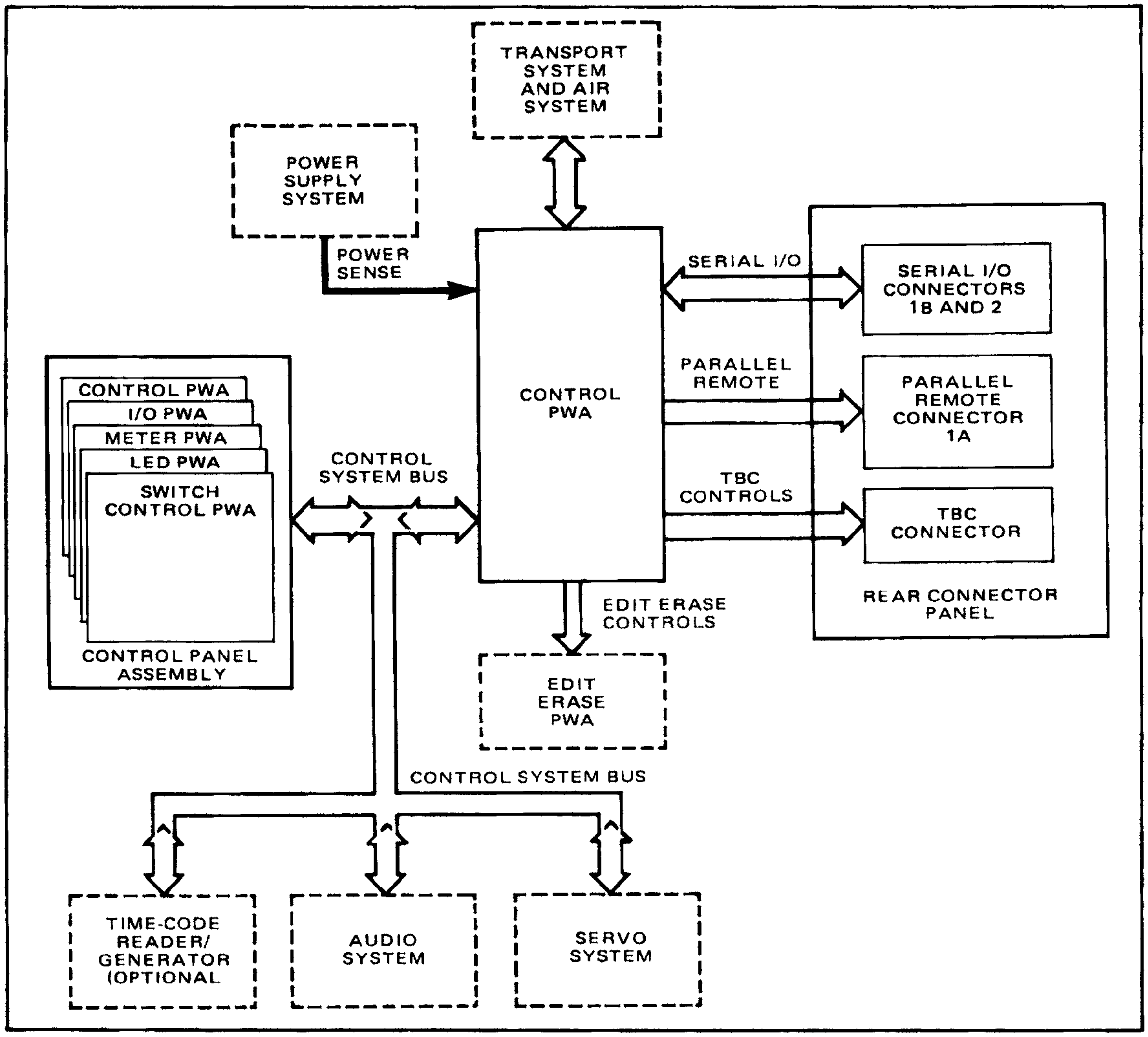


Figure 2-7. VPR-3 Control System

code reader/generator, and the Edit Erase PWA. It also provides control signals to the video system (using the Audio Control PWA as an intermediary). The other microprocessor is used for input/output processing and communications with external equipment.

2-25 Reference System

The Reference PWA produces various sync-related reference signals required by the machine to play back (in normal as well as jog and varispeed modes), record, and edit in synchronism with the reference signals supplied to it. A block diagram of the reference system is shown in Figure 2-8.

In a VTR it is necessary to phase-lock the scanner to a reference so that it has a defined angular position, with the exact position depending on the machine's operating

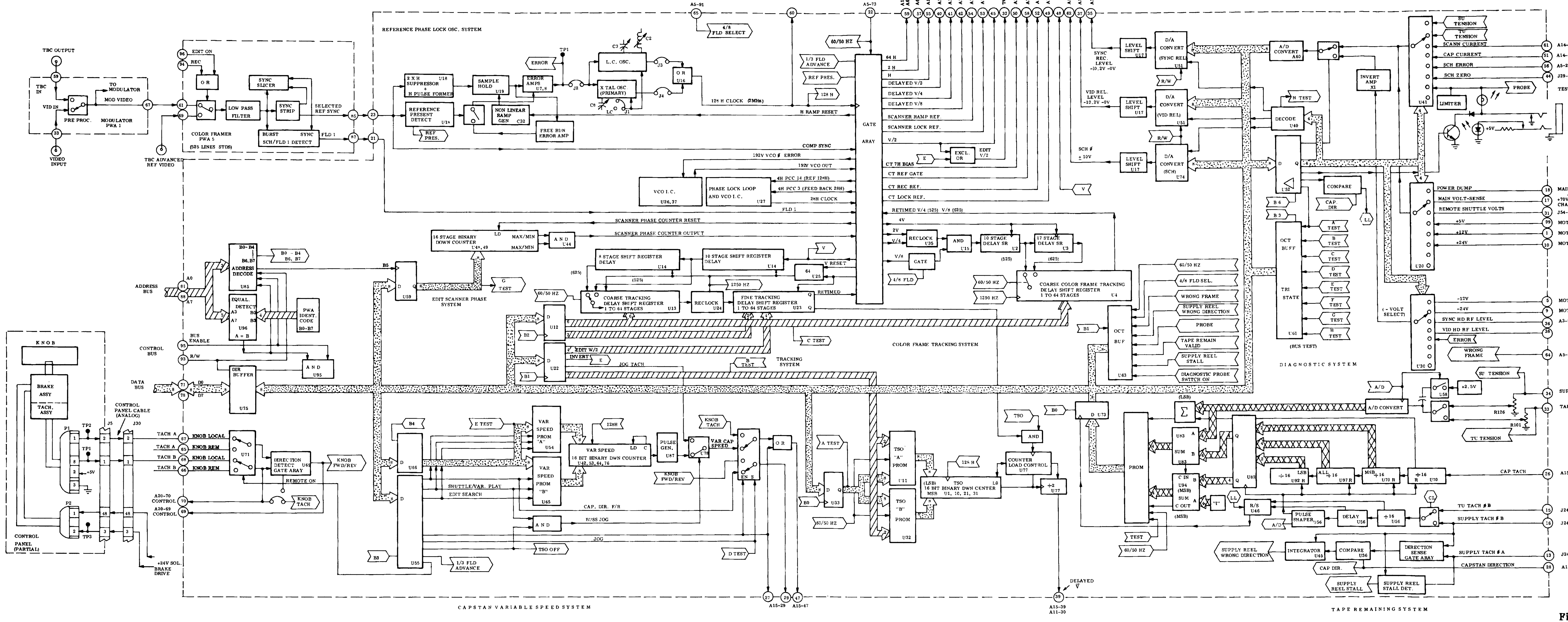


Figure 2-8.
VPR-3 Reference System

mode. During normal playback, the AST head should leave contact with the tape (format dropout) as it moves into the area between the scanner's entrance and exit guides. This should happen simultaneously with the occurrence of reference vertical. Thus, scanner position is controlled by an error signal developed by measuring timing error between the occurrence of scanner vertical tach and the vertical reference that the Reference PWA synthesizes from the reference sync signal (house reference).

Scanner servo error is developed from two feedback error paths: a velocity servo which brings the scanner to the right speed, and a phase servo which only begins to operate when the speed is correct. Phase error is determined by measuring timing between the reference signal and the phase of the scanner's once-per-revolution tach signal. The scanner phase error signal is developed on the Reel and Scanner Servo PWA by comparing a phase error measurement ramp with tach vertical. The Reference PWA produces the scanner ramp reference pulse which initiates a scanner phase error measurement ramp on the Reel and Scanner Servo PWA.

The Reference PWA receives reference sync from the Color Framer PWA which strips sync from selected reference video. Reference video can be the TBC output (preprocessed record video), other video supplied directly to the VPR, or TBC advanced reference video. An oscillator (LC or crystal) on the Reference PWA is locked to selected reference sync, and produces a 2-MHz (128H) signal from which the various reference pulses are derived.

Because the C-Format scanner has three sets of heads, it is necessary to lock up in three different phases in order to use record, playback, or AST heads. To do this, the Reference PWA inserts a 1/3-field (120°) delay or advance in the reference.

The color framer selects TBC-advanced ref video during playback mode. For playback via a TBC, reference is ahead of station sync by one-half the TBC window, and this is compared with the once-per-revolution scanner tach signal. For record, reference is station sync and the Reference PWA inserts a 120° delay to bring the record head into use, again comparing with scanner tach phase. For insert and assemble on a nonstandard tape, the scanner can phase-lock to off-tape vertical as it plays back with the record head during preroll.

During variable speed playback, when capstan speed is under operator control via the knob on the control panel, the Reference PWA generates capstan control signals developed from control knob tach signals.

2-26 Servo System

Figure 2-9 is an overall block diagram of the servo system, which consists of the scanner servo system, capstan servo system, AST servo system, and reel servo systems.

2-27 Scanner Servo System

The scanner servo system controls scanner speed and phase. It is necessary to phase-lock the scanner to a reference so that it will have a defined angular

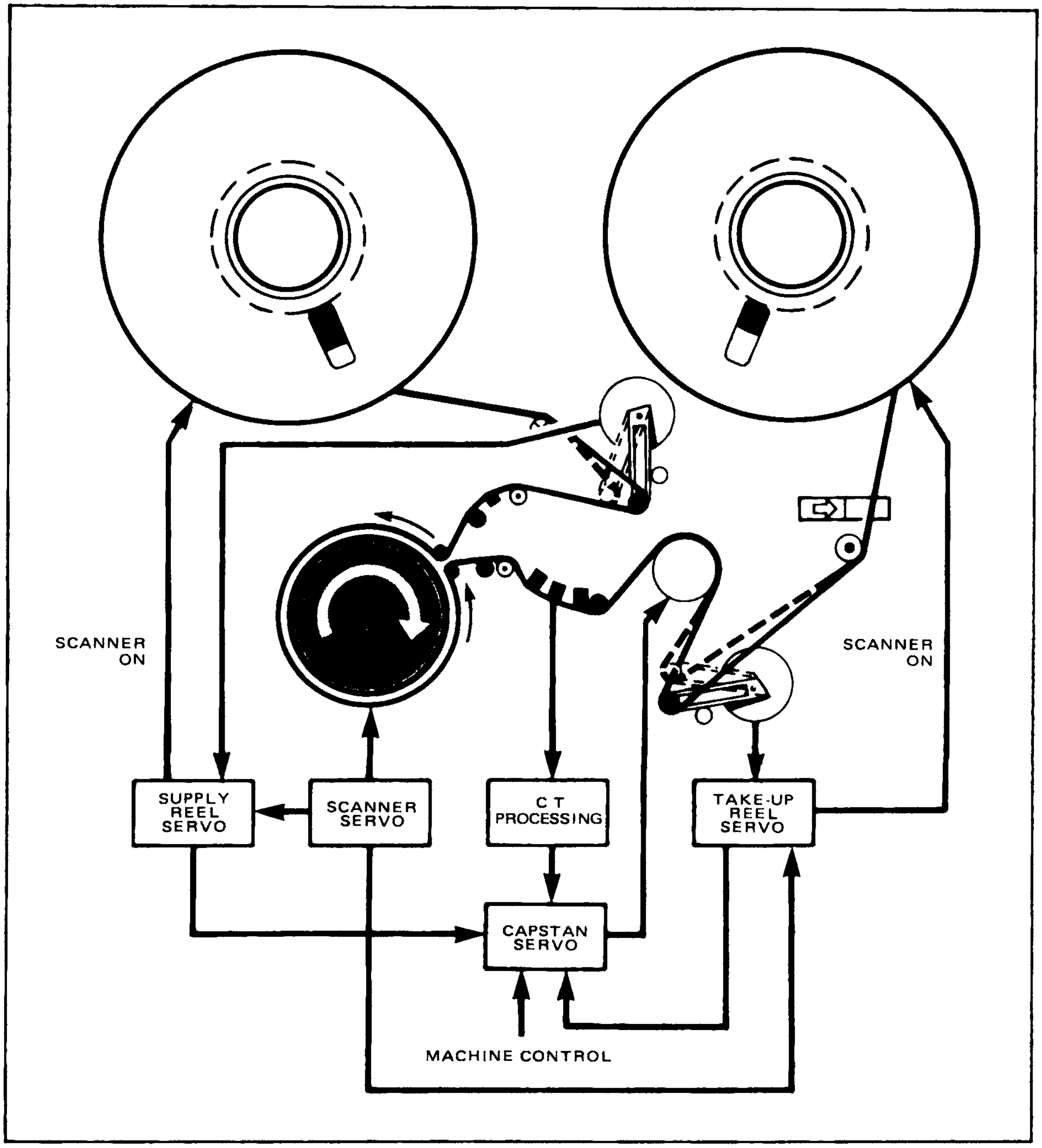


Figure 2-9. VPR-3 Servo System

position relative to reference vertical sync. For this purpose, two feedback paths are used, a high-resolution tach loop and a once-around vertical tach loop. See Figure 2-10.

The motor drive amplifier on the Capstan and Scanner MDA PWA generates current that drives the scanner's brushless dc motor. Drive current is proportional

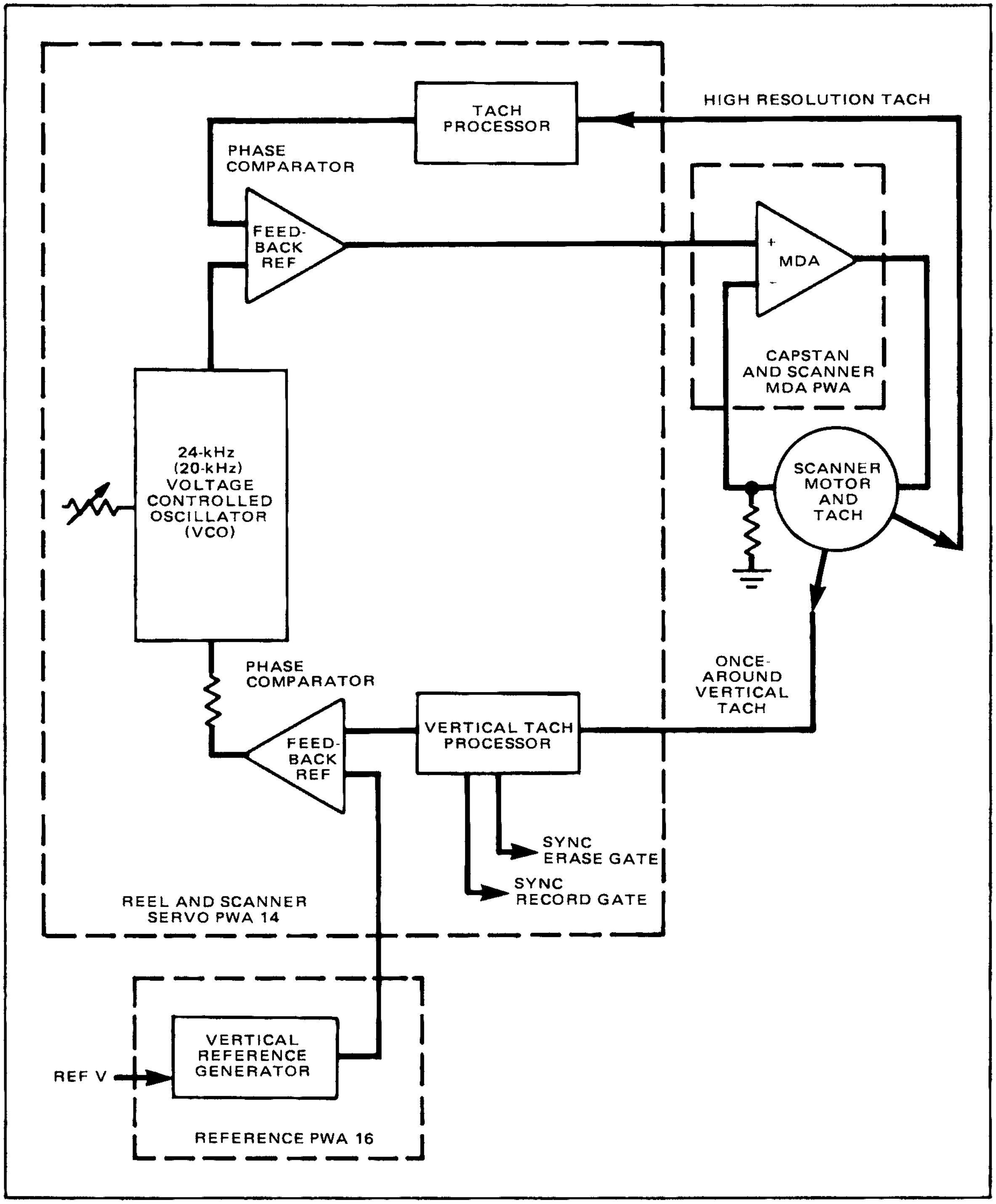


Figure 2-10. Scanner Servo System Block Diagram

to an error signal generated by a digital phase comparator on the Reel and Scanner Servo PWA. The error signal is proportional to the frequency and phase error of the scanner.

A scanner phase error signal is developed by the phase comparator which compares the vertical tach signal generated by the scanner tach with the reference vertical signal produced by the vertical reference generator on the Reference PWA. The scanner phase error signal alters the frequency of the voltage-controlled oscillator, which provides reference frequency to a frequency comparator circuit. The frequency comparator circuit compares the voltage-controlled oscillator frequency with frequency of the high-frequency tach signal fed back from the scanner tach, and produces the error signal used by the MDA. Thus, scanner speed and phase are controlled and adjusted for all VPR operating modes.

2-28 Capstan Servo System

Playback (and record) speeds are determined by capstan speed. The capstan, driven by the dc motor built into the base of the capstan assembly, draws tape past the tape guides and around the scanner. A block diagram of the capstan servo system is given in Figure 2-11.

The motor's drive current is developed by the Capstan and Scanner MDA PWA located in the power chassis at the rear of the VPR. Drive current is proportional to the capstan error signal produced by the Control Track and Capstan Servo PWA and amplified on the Reel and Scanner Servo PWA.

The capstan error signal is developed by comparing a speed reference signal with the tachometer signal that is fed back from the optical tachometer built into the capstan assembly. The tachometer signal contains actual tape speed/direction information, and the speed reference signal contains desired tape speed and direction information.

The selected speed reference signal can be a variable speed reference signal generated by the variable speed control knob, or it can be chosen from among a 1X, 2X, or 1/2X play speed reference signal locked to the control track, or a synthetic control track signal. Selection is in response to commands applied to the Control and Capstan Servo PWA by the system data bus.

2-29 AST Servo System

The automatic scan tracking (AST) servo system (see Figure 2-12) assures that during playback the video head follows the recorded video track. In record mode, the AST head is used to track recorded video to provide video confidence playback. It consists of a positionable reproduce video head controlled by a closed-loop electronic servo system. Playback rf is picked up by the head and amplified by the RF Preamp PWA, and routed through the Equalizer PWA to the AST Servo PWA. Relative playback rf amplitude indicates when the head is on or off track. Circuits on the AST Servo PWA generate signals that keep the AST head on track.

The AST head assembly consists of a ferrite head mounted on a cantilevered piezo-ceramic flexure element. See Figure 2-13.

The head can be electronically deflected 0.5 mm or ±1 video track by the correction signal that is generated by the AST Servo PWA and amplified by the AST driver circuits on the 24V Regulator/AST Driver PWA.

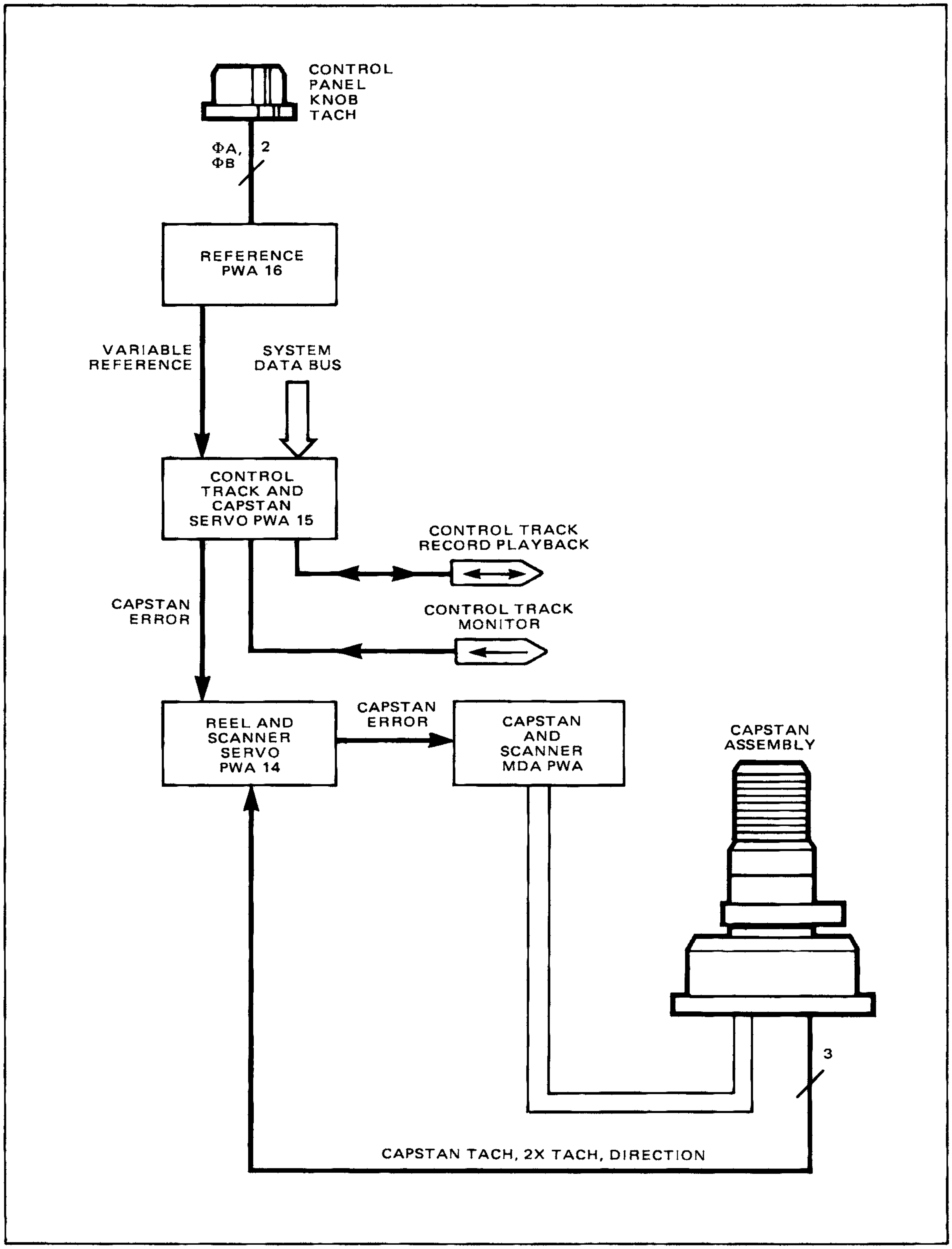

CONTROL PANEL KNOB TACH
ΦA, ΦB
2
REFERENCE PWA 16
VARIABLE REFERENCE
SYSTEM DATA BUS
CONTROL TRACK AND CAPSTAN SERVO PWA 15
CONTROL TRACK RECORD PLAYBACK
CONTROL TRACK MONITOR
CAPSTAN ERROR
REEL AND SCANNER SERVO PWA 14
CAPSTAN ERROR
CAPSTAN AND SCANNER MDA PWA
CAPSTAN ASSEMBLY
3
CAPSTAN TACH, 2X TACH, DIRECTION

Figure 2-11. Capstan Servo System Block Diagram

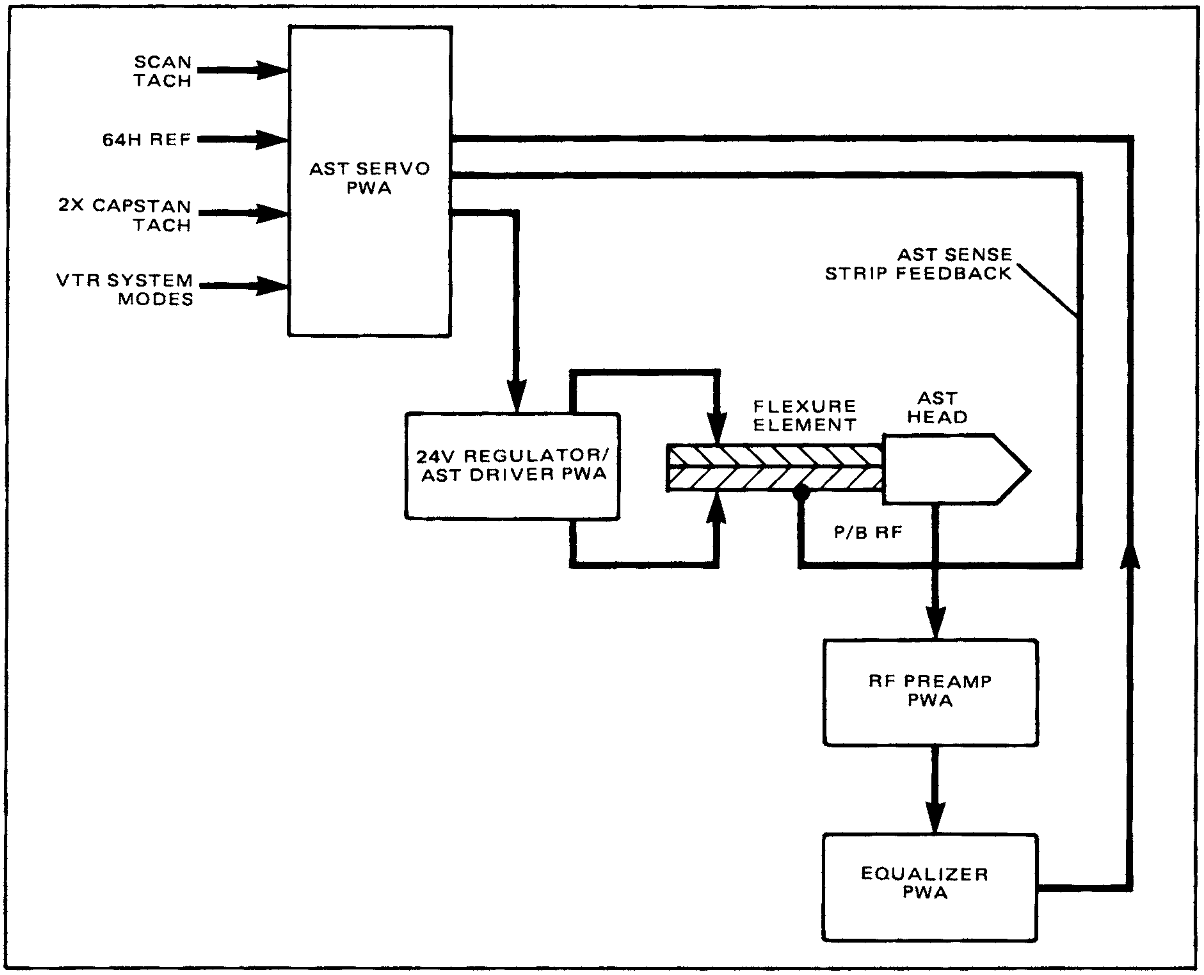


Figure 2-12. AST Servo System Block Diagram

The amount of head deflection required to keep the video head on track depends on tape speed and interchange error. Interchange error is mistracking due to variations in geometry of the tape wrap on the scanner between the VTR that records and the VTR that plays back.

The AST Servo PWA provides main control circuits for the AST servo loop. It generates the AST servo correction signal by summing two separate correction signals and a dither signal that are generated on the PWA. Correction signals are the dynamic correction component, the dither component, and the tracking component.

To derive tracking information, the AST head must be continuously and synchronously wobbled or dithered, so that the head predictably goes slightly off track and amplitude-modulates recovered rf. The dither component is a controlled tracking error component that sinusoidally vibrates the head transversely across the track. The playback rf envelope amplitude varies synchronously with the frequency of the dither sinusoid as the head alternately moves toward, then away from, the center

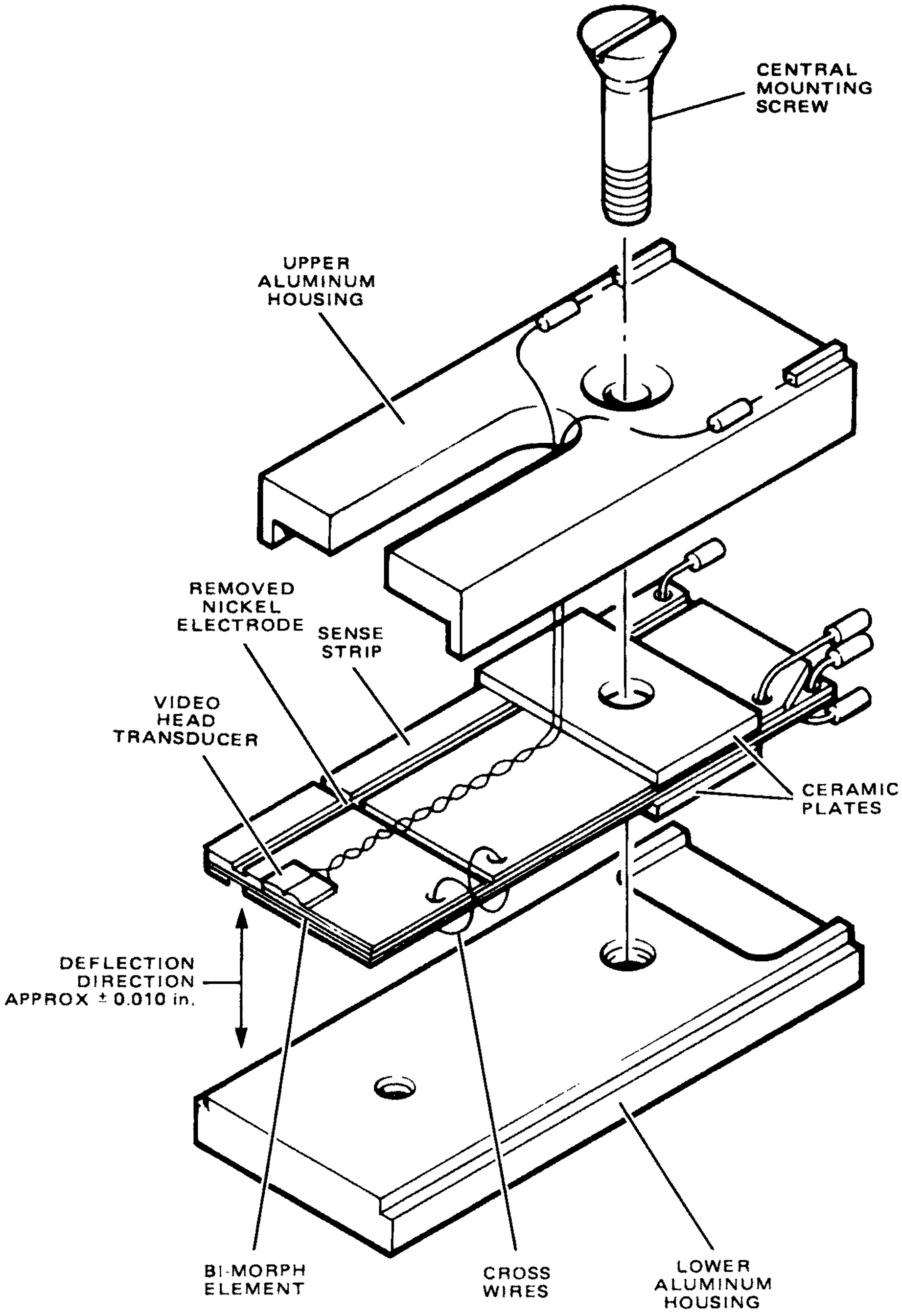


Figure 2-13. Exploded View of AST Head

of the recorded track. Whenever the dc component of the composite head deflection signal is such that it does not place the head at the center of the track, the envelope phase of the video rf signal relative to the phase of the dither frequency provides the indication of whether the head is to the left or right of the recorded track. Tracking error detection via dithering is illustrated by Figure 2-14.

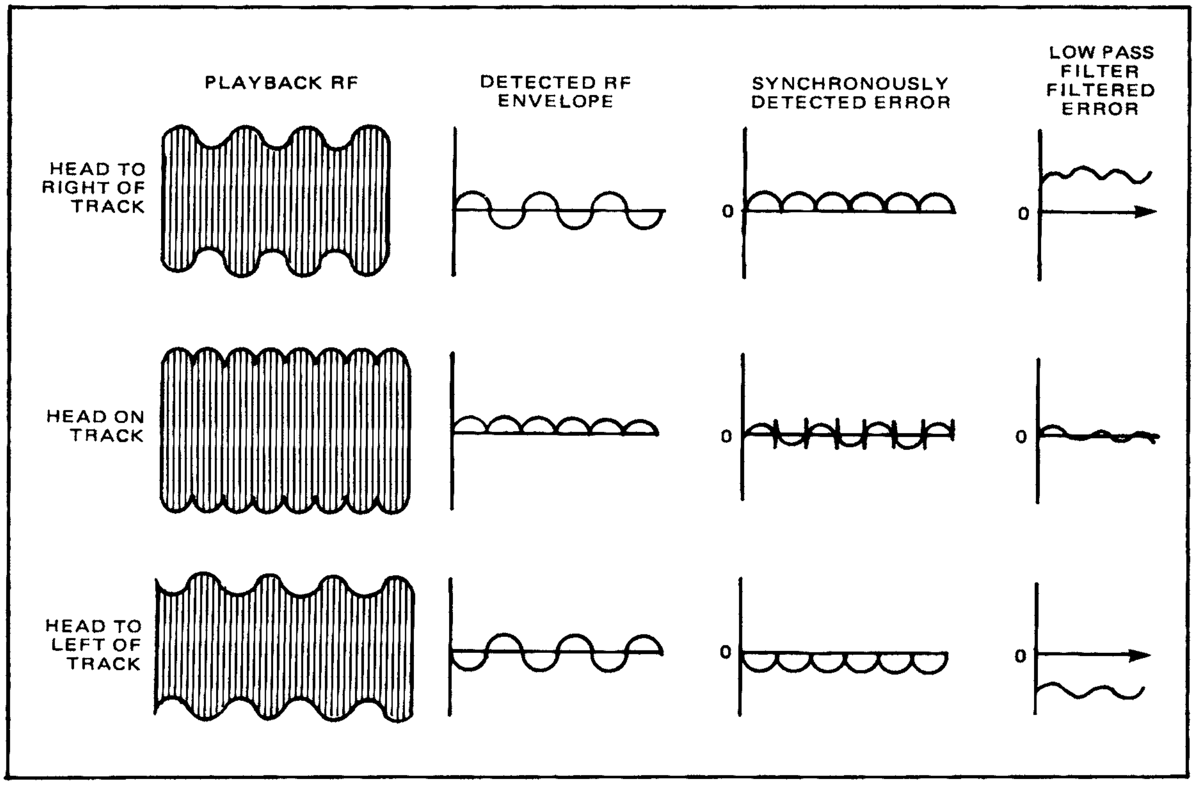


Figure 2-14. DC Error Detection

A decrease in rf envelope indicates the head is off track, but does not indicate the direction of the error. Synchronous detection of the amplitude-modulated rf that results from dithering the head provides direction information. When the head is on track, the dither signal deflects it off track by an equal amount in both directions. As a result, the detected rf envelope is the same for each half cycle of dither frequency. This signal is synchronously detected at dither frequency; polarities of alternate half-cycles are reversed synchronously with polarity changes in the dither signal. The resulting error waveform is filtered to eliminate the dither component and provide an average dc error value (in this case, zero). When the head is to the right of the track, it is deflected for a greater average error to the right side than to the left, resulting in a filtered dc error component. With the head to the left of the track, deflections will cause an average dc error of opposite polarity.

The dynamic correction component of the tracking correction composite is synthesized from tracking errors detected by the synchronous detector. Dynamic correction compensates for tracking errors experienced by the video head as a result of periodic repetitive disturbances that are related to head rotation frequency. These periodic errors are typically generated as a result of interchange errors that occur because of tracking geometry differences between the machine that records and the machine that plays back.

The tracking component provides the head positioning waveform required during special effect reproducing. It is synthesized from digital data stored in a read-only memory. Because the trajectory the tip must follow in order to remain on the recorded track depends on tape speed, tape speed information is used to develop addresses that access appropriate data.

2-30 Reel Servo System

The reel servo system (see Figure 2-15) controls tape supply and takeup motors. Motors are controlled as necessary to produce appropriate reel speeds and tape tensions during the various VPR operating modes. Supply and takeup reel motor drive currents are produced on the Reel MDA PWA from error signals developed on the Reel and Scanner MDA PWA. System operation mode and status information is supplied by the Control PWA to the Reel and Scanner Servo PWA via the system bus. Tape tension and speed information, produced by photo pots in the tape tension arms and tachometers in the reel motor assemblies, is fed to the Reel and Scanner Servo PWA.

2-31 Monitor System

Figure 2-16 is a block diagram of the VPR-3 monitoring system. Using controls on the transport control panel, the operator can route the input and output program material to monitoring accessories provided with a particular VPR-3 configuration. A picture monitor, waveform monitor, and vectorscope display the video. A video rf meter on the transport control panel provides video level indications. Four audio level meters, one for each of the audio channels, is provided on the control panel. Audio can be monitored on the transport or console audio monitors as well as through the headset jack on the transport control panel.

When AUX on the control panel is selected, the scanner servo error, capstan servo error, supply servo error, takeup servo error, AST dynamic error, or the control track record signal can be selected for monitoring on the waveform monitor. The AUX MON rotary switch on the front of the Reel and Scanner Servo PWA is used to make this selection.

2-32 Power Supply Subsystem

A block diagram of the VPR-3 power system is shown in Figure 2-17. Power supply circuitry includes the power supply motherboard, the Regulator and the 24V Regulator, AST Driver PWAs.

The power supply can use primary power from 95 to 270 Vac. The power transformer primary windings are connected in parallel for 95V to 135V operation, and in series for 190V to 270V operation. Two jumper plugs are used for selecting appropriate input voltage windings within ranges of 95 to 135 Vac or 190 to 270 Vac. Instructions for installation of line voltage selector plugs are placarded on the back panel of the power supply chassis; instructions are visible when the power

Table 1-8. VPR-3 Specifications

Characteristics	PAL/SECAM 625/50	NTSC/PAL-M 525/60
Video and Sync		
Bandwidth	flat to 5.0 MHz ±0.5 dB -3 dB at 6.0 MHz	flat to 4.2 MHz ±0.5 dB -3 dB at 5.0 MHz
Signal-to-noise (Rohde and Schwarz unweighted with bandpass filter) using TBC-3	-44 dB p-p video to RMS noise on interchange basis	-47 dB p-p video to RMS noise on interchange basis
LF linearity	2% blanking to white maximum	2% blanking to white maximum
Differential gain	4% blanking to white maximum	4% blanking to white maximum
Differential phase (40 IEEE units of subcarrier through TBC-3)	4° at 4.43 MHz off-tape maximum	4° at 3.58 MHz off-tape maximum
Chrominance/Luminance Delay	25 ns max	20 ns maximum
2T sin^2 pulse and bar	1% K-factor maximum	1% K-factor maximum
Moiré	-36 dB color bars 75% amplitude 4.43 MHz subcarrier	-40 dB color bars 75% amplitude 3.58 MHz subcarrier
Audio (CH 1, 2, and 3)		
Frequency response (400 Hz ref) 100 nWb/m reference level	±1 dB 200 Hz to 12 kHz ±2 dB 50 Hz to 18 kHz	±1 dB 200 Hz to 12 kHz ±2 dB 50 Hz to 18 kHz
Signal-to-noise (with respect to +8 dB above reference level) 20 Hz to 20 kHz	-56 dB audio 1 and 2, -54 dB for Audio 3(1)	-56 dB audio 1 and 2, -54 dB for audio 3(1)
Distortion (measured at 1 kHz)(3 HD)		

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Table 1-8. VPR-3 Specifications (Continued)

Characteristics	PAL/SECAM 625/50	NTSC/PAL-M 525/60
Audio (CH 1, 2, and 3) (Continued)		
@ 100 nWb/m reference	1% max	1% max
@ 251 nWb/m peak level	3% max	3% max
Predistortion at 200 nWb/m (+14 dBm)	1% max	1% max
Depth of erasure on its own recording	-70 dB	-70 dB
Wow and flutter	0.07% DIN weighted (R/P)	0.07% NAB unweighted (flutter tape)
Playback crosstalk (audio 1 and 2) 1 kHz referenced to +8 dBm or 100 nWb/m	-60 dB max	-60 dB max
General		
Record time	190 min nominal; 9200 ft of tape	190 min nominal; 9200 ft of tape
Shuttle time	less than 72s for 60-min tape, 3.6 min for a 3-hr tape.	less than 72s for 60-min tape, 3.6 min for a 3-hr tape.
Tape timer accuracy (control track updated)	±0.1 field with continuous control track	±0.1 field with continuous control track
Tape speed	239.8 ±0.5 mm/s; 9.44 ±0.02 in/s	244 ±0.5 mm/s; 9.606 ±0.02 in/s;
Video writing speed	842 in/s nominal	1009 in/s nominal
FM carrier frequencies	7.68 MHz blanking, 8.9 MHz peak white	7.9 MHz blanking 10.0 MHz peak white
Audio equalization (time constants)	15 µs 3180 µs	15 µs

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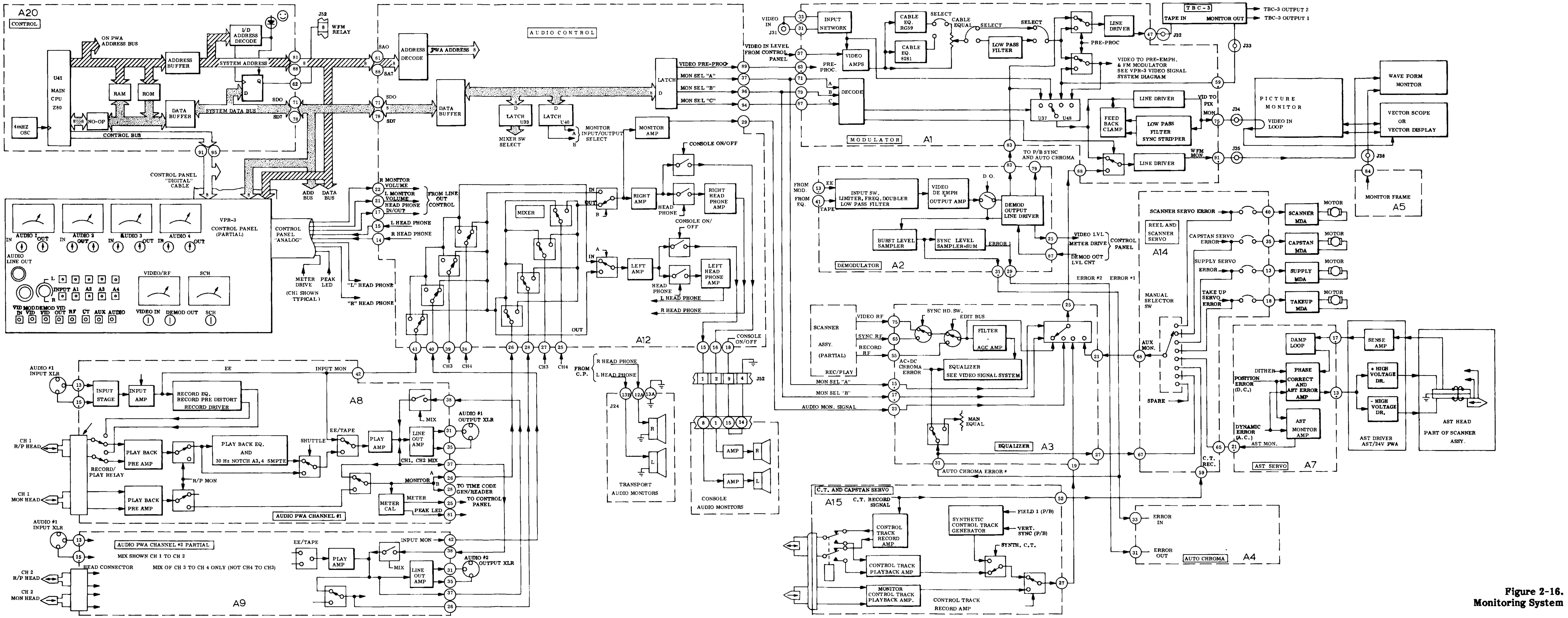


Figure 2-16. Monitoring System

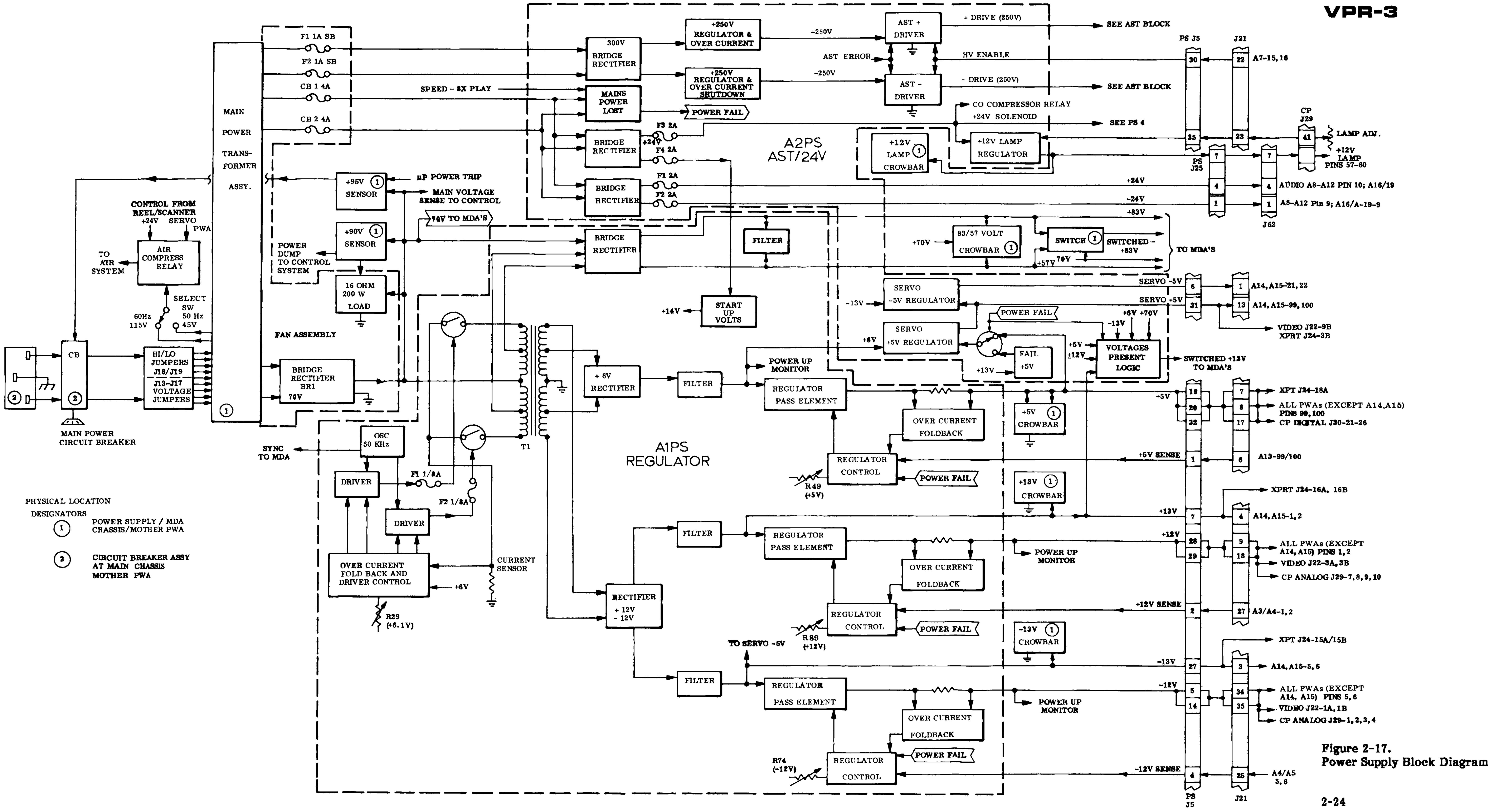
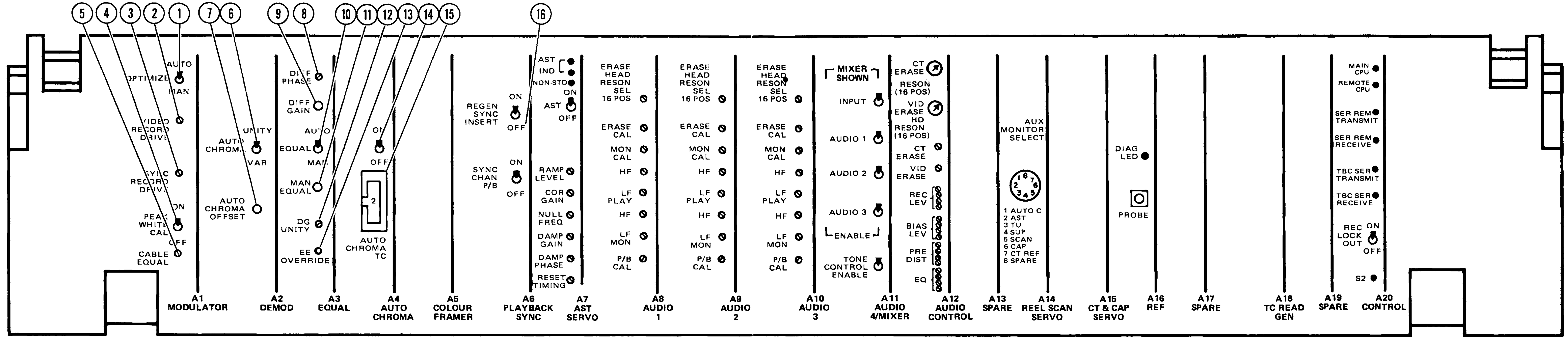


Figure 2-17.
Power Supply Block Diagram

Table 2-1. Electronics Bay PWA Edge Controls



Index No.	Description	Function
1	OPTIMIZE AUTO/. MAN toggle	Enables manual or automatic optimization of the video and sync record drives. When set to MAN, VIDEO RECORD DRIVE control (Index No. 2) and SYNC RECORD DRIVE control (Index No. 3) are enabled and can be used to control record drive current in video and sync channels during optimization process. When set to AUTO, sync and video record heads can be automatically optimized when initiated via the Automatic Tape Optimization menu. The procedure for automatically optimizing video and sync record currents for three tape types via the Automatic Tape Optimization menu is given in Section 3.
2	VIDEO RECORD DRIVE potentiometer R325 PWA 1	Adjust to optimize video record head drive current. Enabled only when OPTIMIZE AUTO/MAN (Index No. 1) is set to MAN.
3	SYNC RECORD DRIVE potentiometer R326 PWA 2	Adjust to optimize sync record head drive current. Enabled only when OPTIMIZE AUTO/MAN (Index No. 1) is set to MAN.
4	PEAK WHITE CAL ON/OFF toggle switch S2 PWA 2	Turns video system calibration pulse on or off. Pulse is four-horizontal-line-wide peak white frequency. Pulse is injected on Modulator PWA during vertical interval. Observe DEMOD VID on waveform monitor; if necessary adjust DEMOD OUT for 140 IEEE p-p.
5	CABLE EQUAL potentiometer R211 PWA 1	Adjust to equalize losses in video input cable. Use in conjunction with jumper J6 on Modulator PWA. Adjust when VPR-3 is first installed and whenever the length or type of video input cable is changed.
6	AUTO CHROMA UNITY/VAR toggle switch S1 PWA 2	Set to UNITY when recording was produced using standard sync-to-burst ratio. Set to VAR for non-standard sync-to-burst ratio to enable AUTO CHROMA OFFSET control (Index No. 7).
7	AUTO CHROMA OFFSET potentiometer R107	Adjust to correct playback color of recordings with nonstandard sync-to-burst. Control is enabled only when AUTO CHROMA UNITY/VAR PWA 2 (Index No. 6) is set to VAR.
8	DIFF PHASE potentiometer R1 PWA 3	Adjusts differential phase in playback signal. Requires test signal for best adjustment.
9	DIFF GAIN potentiometer R38 PWA 3	Adjusts differential gain in playback signal. Requires test signal for best adjustment.
10	EQUAL AUTO/ MAN toggle switch S1 PWA	Enables automatic equalization control when set to AUTO. When set to MAN, manual control of equalization via MAN EQUAL control (Index No. 11) is enabled.
11	MAN EQUAL potentiometer R67 PWA 3	Provides equalization adjustment for playback video channel (preferably with a recorded test signal). Disabled when EQUAL AUTO/MAN switch is in AUTO position.
12	DG UNITY Potentiometer R101 PWA 3	Sets unity differential gain. Adjust so that best differential gain adjustment occurs when DIFF GAIN control (Index No. 9) is centered.
13	EE OVERRIDE pushbutton	Forces system to E-E mode during playback. This is useful during system testing to compare EE color bars to playback color bars.
14	ON/OFF toggle switch	When set to ON, enables automatic chrominance correction of playback signal on a line-by-line basis. Disables this correction when set to OFF.
15	AUTO/CHROMA T.C. thumbwheel switch	Sets time constant for automatic chrominance control. Rapid chrominance corrections are made when set to higher numbers. Slower changes occur when set to lower numbers. Range of settings is from 0 to 15. Zero setting produces an infinite time constant (correction signal will not change). In the setting range of from 1 to 15, the time constant range varies from about 10s to about 1s. Settings providing the shorter time constants could result in poorer signal-to-noise.
16	SYNC CHAN P/B switch S1	Enables playback sync channel head provided there is sync channel rf P/B present. This switch can be left on (enabled) during reproduction of non-sync tapes without affecting the dropout duration.
	ON	Enables playback sync channel head switching.
	OFF	Disables playback sync channel switching at all times.

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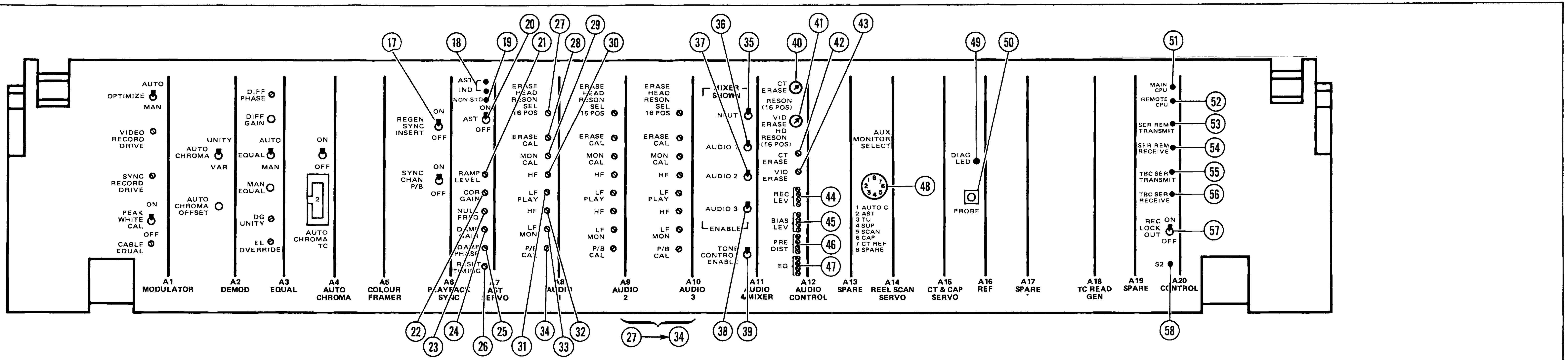
Table 2-1. Electronics Bay PWA Edge Controls (Continued)



Index No.	Description	Function
17	REGEN SYNC INSERT switch S2	Enables insertion of artificially generated composite sync during format dropout time. This allows any device requiring complete vertical sync signal for proper operation to operate without disturbance on the VTR DE-MOD output signal. This insertion signal is present in normal play and stop on VPR-3s operating in 525-line standards and only in normal play on 625-line standards. This signal will be automatically disabled in favor of the actual playback sync channel if S1 (Index No. 16) is on and there is a sync channel recording on tape. If both S1 and S2 are enabled and the tape being reproduced has a sync channel recording, the system will enable the preferred sync channel reproduce instead of the artificial comp sync.
	ON	Enables artificial composite sync insertion.
	OFF	Disables artificial composite sync insertion.
18	AST IND LEDs (2 green LEDs)	Both green LEDs flicker on and off when automatic scan tracking (AST) is operating correctly.
19	NON-STD LED (amber LED)	Lights to indicate nonstandard LED AST operation. Follows AST setup jumper J2 on AST Servo PWA. If jumper is set to any position other than OPR A (operate), LED illuminates.
20	AST ON/OFF toggle switch S1 PWA 7	Turns AST servo on or off.
21	RAMP LEVEL potentiometer R121 PWA 7	Controls drive level to AST head. May need adjustment if abnormal deviations of rf envelope are noticed.
22	COR GAIN R122 PWA 7	Controls the amount of linearity correction in the head drive signal. Used to set up AST system when replacing AST heads.
23	NULL FREQ potentiometer R143 PWA 7	Normalizes AST head parameters for proper damping setup. Used to set up AST system when replacing AST heads.
24	DAMP GAIN potentiometer R144 PWA 7	Controls AST head damping gain. Used to set up AST system when replacing AST heads.
25	DAMP PHASE potentiometer R145 PWA 7	Controls AST head damping phase. Used to set up AST system when replacing AST heads.
26	RESET TIMING potentiometer R187 PWA 7	Controls AST correction reset timing. Used to set up AST system when replacing AST heads.
27	ERASE HEAD RESON. SEL. 16-position switch S1 PWA 8 potentiometer	Optimizes audio erase channel by tuning erase head circuit for resonance with frequency of erase head drive current.
28	ERASE CAL potentiometer	Erase head current adjust control.
29	MON CAL potentiometer R102	Monitor head calibration control.
30	HF potentiometer	High frequency playback equalization control.
31	LF PLAY potentiometer	Low frequency playback equalization control.
32	HF potentiometer	Monitor head high frequency equalization control.
33	LF MON potentiometer	Monitor head low frequency equalization control.
34	P/B CAL potentiometer	Playback calibration control
35	INPUT toggle switch	Turns on or off input audio (input jack labeled Audio 4 on the back of the VTR).
36	AUDIO 1 ENABLE toggle switch	Enables audio 1 channel for mixing.
37	AUDIO 2 ENABLE toggle switch	Enables audio 2 channel for mixing.
38	AUDIO 3 ENABLE toggle switch	Enables audio 3 channel for mixing.

(Continued next page)

Table 2-1. Electronics Bay PWA Edge Controls (Continued)

Index No.	Description	Function
39	TONE CONTROL ENABLE toggle switch	Enables equalization adjustment of all channels.
40	CT ERASE RESON 16-position switch	Optimizes control track erase channel by tuning erase head circuit for resonance with frequency of erase head drive current.
41	VID ERASE HD RESON 16-position switch	Optimizes video erase channel by tuning erase head circuit for resonance with frequency of erase head drive current.
42	C.T. ERASE potentiometer R135	Adjusts level of erase current supplied to control track erase head.
43	VID ERASE potentiometer R136	Adjusts level of erase current supplied to video erase head.
44	REC LEV 4 potentiometers R137-R140	There are four controls in the REC LEV group. Each controls the record level in one of the four audio channels. The topmost control adjusts audio 1 channel. the controls below adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.
45	BIAS LEV 4 potentiometers R177-R180	There are four controls in the BIAS LEV group. Each controls the bias level in one of the four audio channels. The topmost control adjusts audio 1 channel; the controls below adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.
46	PRE DIST 4 potentiometers R192-R195	There are four controls in the PRE DIST group. Each controls the predistortion level in one of the four audio channels. The topmost control adjusts audio 1 channel; the lower controls adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.
47	EQ 4 potentiometers R202-R205	There are four controls in the EQ group. Each controls the playback equalization in one of the four audio channels. The topmost control adjusts audio 1 channel; the controls below adjust audio channels 2, 3 and 4. These controls can be set from the Preset Setup menu.
48	AUX MONITOR	Determines which signal is applied to the waveform monitor when the AUX pushbutton on the operator's control panel is pressed.
	1. AUTO C	Selects auto chroma error.
	2. AST	Selects AST drive signal.
	3. T.U.	Selects takeup reel drive current.
	4. SUP	Selects supply reel drive current.
	5. SCAN	Selects scanner drive current.
	6. CAP	Selects capstan drive current.
	7. CT REF	Selects control track reference signal.
	8. Spare	Not used.
49	DIAG LED	
50	PROBE	Use with diagnostic menus for fault isolation
51	MAIN CPU LED	Flickers when main microprocessor is running. Flashes once on field II.
52	REMOTE CPU LED	Flickers when remote microprocessor is running. Flashes once on field I.
53	SER REM TRANSMIT LED	Flickers when data is transmitted to remote unit from serial 1 and serial 2 interconnect.
54	SER REM RECEIVE LED	Flickers when data is received from remote unit from serial 1 and serial 2 interconnect.
55	TBC SER TRANSMIT LED	For future use.
56	TBC SERIAL RECEIVE LED	For future use.
57	REC LOCK OUT ON/OFF toggle switch	Locks out recording on all channels. VPR cannot record when this switch is ON.
58	S2 pushbutton	Control system reset switch. Resets microprocessors. To clear all of RAM push S2 while simultaneously pushing VIDEO IN and AUDIO monitor pushbuttons. **CAUTION** **THIS WILL ERASE TAPE SETUP INFORMATION AND ALL PARAMETERS STORED IN MEMORY. THIS IS COMMONLY REFERRED TO AS "FIRST BIRTHDAY".**

SECTION 3
VIDEO SYSTEM

3-1 INTRODUCTION

This section provides overall theory of operation, as well as block diagrams, alignment procedures, and jumper and test point tables for the VPR-3 video system.

3-2 VIDEO SYSTEM OVERALL THEORY OF OPERATION

The video system provides signal processing required for recording, playing back, and monitoring a composite video signal. In record mode, composite video signal from a camera, VTR, or other source frequency-modulates an rf carrier signal which is used to drive the record head. In play mode, the reverse occurs; rf from the play head is demodulated and otherwise processed into appropriate video for studio use (via time-base corrector) and monitor operation.

Video information is recorded on tape in the form of a frequency-modulated carrier signal. Frequency modulation is used because the video signal has a frequency span of more than 18 octaves, while the usable span of magnetic tape is about 10 octaves. Low-frequency roll-off of 6 dB per octave, and high-frequency roll-off due to head gap, make it impractical to compensate in direct recording beyond the 10-octave span because of signal-to-noise considerations. With frequency modulation, the span is reduced to about three octaves while retaining the original bandwidth.

A video system block diagram is shown in Figure 3-1.

Video record/playback heads are mounted in the scanner, which rotates in a clockwise direction, while tape travels around the scanner in a counterclockwise direction. Tape elevates as it travels around the scanner (by guides, not shown)—an action which allows for the helical tracks laid down by scanner heads which pass across the tape at an angle.

The scanner has six heads, three for program video, and three for optional sync track. A machine lacking the sync track function will have nonfunctional dummy heads installed in place of sync track heads. These heads provide the balance needed, and preserve head-to-tape geometry required for Type-C operation.

The video playback head is an Automatic Scan Tracking (AST*) head. This head can be deflected transversely to the recorded track (up to 0.5 mm or ±1 video track) and be made to follow the track if (due to any deviations from geometry specified by the Type-C format standard) the track tends to drift away from the head. In record mode, the AST head is used to track recorded video to provide video confidence playback. Other heads in the scanner are fixed heads and are not deflected.

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* Trademark, Ampex Corporation

The AST head is driven by the AST system which is a closed-loop electronic servo system. Playback rf is picked up by the head, amplified by the RF Preamp PWA, and routed through the Equalizer PWA to the AST Servo PWA. Relative amplitude of the playback rf indicates when the head is on or off track. Circuits on the AST Servo PWA generate signals that keep the AST head on track.

Rf signals to and from the heads are routed through the Record Driver PWA via six rotary transformers. AST head control signals are coupled to the head by a slip-ring and brush assembly.

3-3 Modulator PWA

The Modulator PWA occupies position 1 of the electronics bay. The PWA's main function is to generate a carrier frequency and frequency-modulate it with the incoming video signal for recording on tape. This PWA also provides variable-gain amplification of input video for record-level control and a cable equalizer circuit that provides jumper-selectable equalization control. In addition, it is the switching point for all VPR-3 system-generated video that can be viewed on waveform and picture monitors; as such, all monitorable video from the VPR-3 enters this PWA.

3-4 Demodulator PWA

The Demodulator PWA occupies position 2 of the electronics bay. This PWA demodulates and amplifies one of two incoming rf signals: either off-tape (playback) rf from the equalizer, or electronics-to-electronics (E-E) rf from the modulator. Demodulated video is applied to the Modulator PWA, where it can be routed through switches to the VIDEO OUT connector on the VPR-3 rear connector panel.

Standard field-rate auto chroma circuitry is located on the Demodulator PWA, and generates an error signal (AUTO CHROMA ERROR), which is sent to the Equalizer PWA.

3-5 Equalizer PWA

The Equalizer PWA occupies position 3 of the electronics bay. It equalizes rf signals sent from the video and sync play heads, removing distortion caused by the record/playback process, and routes the signals to the Demodulator PWA and the AST Servo. Logic is provided to allow the auto chroma error to control equalization. In addition, this PWA functions as the switching point for various system-generated waveforms that can be viewed on the waveform monitor; control signals supplied by the Audio Control PWA switch the selected waveform to the waveform monitor.

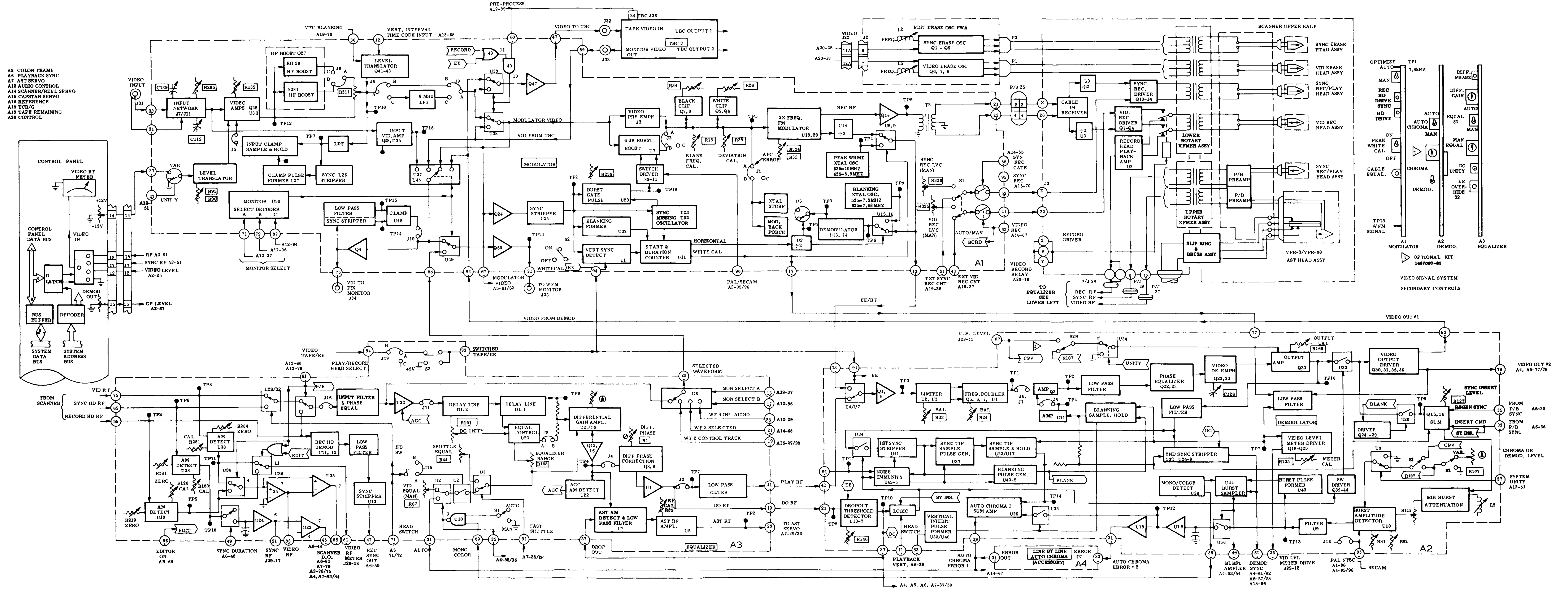

Figure 3-1. Video Signal System Detailed Block Diagram

3-6 Record Amplifier PWA

The Record Amplifier PWA plugs into the lower portion of the scanner assembly. In record mode, this PWA amplifies the rf signal from the Modulator PWA, then directs this signal to the video record head (and sync record head, if so equipped). To reduce moiré, the carrier frequency of the fm circuit on the Modulator PWA is operated at twice normal frequency. The Record Amplifier PWA divides this modulated carrier signal by two before recording it on tape. During edit play mode, an rf signal is received from the video record head, amplified, and then directed to the equalizer. Two versions of this PWA exist to accommodate both sync option and standard VPR-3 models.

3-7 Video Preamp PWA

The Video Preamp PWA is mounted on the upper (rotating) portion of the scanner assembly. This PWA contains two channels of preamplification, one for the video play head rf signal, the other for the sync play head (if so equipped). Play head signals are amplified and routed through rotary transformers to the Equalizer PWA.

3-8 Edit Erase PWA

The Edit Erase PWA is mounted on the tape transport, and provides edit erase oscillator current (approximately 24 MHz) to the video edit erase and sync edit erase heads in the upper portion of the scanner. Erase oscillators are turned on and off under control of enabling signals produced on the Control PWA by the system's ROM-based software operating program, producing precise, frame-accurate video and sync erasures during edit sessions.

3-9 Auto Chroma PWA

The Auto Chroma PWA (optional) enhances standard field rate auto chroma circuitry by providing line-by-line chrominance correction of the playback signal. Chroma errors are corrected on a line-by-line basis within a field, providing better quality multiple generation tape duplication. The line-by-line equalization control signal is applied to the Equalizer PWA.

3-10 Color Framer PWA

During editing, the Color Framer PWA compares color phase and frame of the playback video and input video to aid in producing color-framed and shift-free edits. It measures the subcarrier phase relative to sync of either the off-tape video or the input video. The measured phase is indicated on the ScH meter. In playback, the Color Framer assures that off-tape video frames match reference video frames. In addition, it determines the transport's precise parking location by identifying the exact field on which tape is stopped. Parked frame information is provided for readout on the fluorescent display panel.

3-11 MODULATOR PWA

The description of this PWA applies to both 525 systems and 625 systems: PAL/SECAM, Assembly No. 1467013 and NTSC, PAL-M, Assembly No. 1467010. Any specific differences are noted.

The Modulator PWA A1 includes the following circuitry:

- An input attenuator with high common-mode rejection.
- Cable equalization that accommodates two different cable types (RG59 or 8281).
- A low-pass filter (jumperable option) to reduce out-of-band noise, preemphasis to Type-C standards.
- 2X burst preemphasis.
- Vertical interval time-code insertion.
- Input monitoring, clamping, crystal afc, white calibrate pulse generation.
- Video and waveform monitor switching, and preprocess switching.

Blanking carrier frequency of the 525-line version is 7.9 MHz, and peak white deviation frequency is 10.0 MHz. For the 625-line version, carrier blanking frequency is 7.68 MHz and peak white deviation frequency is 8.9 MHz.

The Modulator PWA receives composite video from the VTR input, frequency-modulates it, and sends it to the record amplifier on the tape transport for recording. It also provides a frequency-modulated rf output to the Demodulator PWA when the VTR is in the E-E mode. A block diagram of the Modulator PWA is included in Figure 3-1. Also refer to the schematic diagram of the appropriate Modulator PWA.

3-12 Input Network

The 1-Vp-p input video is routed from the VIDEO INPUT connector on the VPR-3 back panel to pins 31-34 on the Modulator PWA which provide the signal with a 75Ω balanced input. An input network includes jumpers J1 and J7 which can be placed to provide an unbalanced input if necessary. Jumper J7 can be set to the A-D position to connect one end of the input signal to ground-through capacitor C118; this is helpful in a high rf field environment operation.

3-13 Input Video Amplifier and Equalizer

Video is applied to a differential video amplifier U33, to which a feedback clamp voltage is applied to establish video blanking at 0 Vdc at TP10. Outputs of this video amplifier are applied to a cable equalizer. The cable equalizer comprises two video paths. One is direct without equalization applied (Q32, 35, 36), and the other has full equalization applied by networks in the emitter circuits of Q27. The two paths are resistively summed in potentiometer R211. The setting of R211 determines how much equalization is applied to the video—from none to up to 1000 feet of selected cable type.

3-14 6-MHz Low-Pass Filter

Equalizer output is amplified by filter driver Q25, 26, and applied to switches U38 and U39 directly or after having been passed through a 6-MHz low-pass filter, as determined by the positioning of jumpers J8 and J9. The filter prohibits possible high-frequency components from entering modulator circuitry, which would tend to produce moiré.

3-15 Vertical Interval Time Code

Vertical interval time code (VITC) is brought into PWA pin 72 at 5V TTL level. It is level-shifted and shaped by Q41, 42, and 43 before being resistively summed with the video at J8.

3-16 Input Video Amplifier Feedback Clamp Circuit

U25, 26, 27, 28, and 29 comprise a feedback clamp circuit for the input amplifier. This circuit clamps the output of the video amplifier and cable equalization network produced at R211 (TP10) to 0V during blanking. The signal on the potentiometer R211 wiper is passed through a low-pass filter and applied to an input clamp sample-and-hold circuit which samples the blanking level. The sampled level is fed back to the video amplifier where it is used to clamp blanking to 0V. The sampling pulse applied to the sample-and-hold filter is developed from sync stripper U26 and clamp pulse former U27.

3-17 Video Preemphasis and 6-dB Burst Boost

Video is preemphasized before being applied to the fm circuit. Type C standard requires that burst be recorded at twice amplitude (i.e., twice deviation for fm); this is achieved by switching in extra preemphasis during burst time. The normal path for the signal is to the fm circuit U19, 20 through network R23, R24, jumper J3. However, during burst time the 6-dB burst boost circuit U7 provides the required burst boost when it is enabled for 3 μs by switch driver Q2, 3, 9, 10. The switch driver is turned on by the 3-μs burst gate pulse produced by burst gate pulse circuit U23, which derives its timing from sync stripper circuit U24.

3-18 Black and White Clipping

Black clip circuit Q7, 8 and white clip circuit Q5, 6 are provided to prevent modulated rf from being over-deviated. Upper and lower limits of peak-to-peak modulation voltage that can be applied to the frequency modulator are set by R34 and R26.

3-19 Frequency Modulator

The frequency modulator operates at twice the normal record carrier frequency; at the output of the modulator, the frequency of peak white signals is 20 MHz (NTSC) or 17.8 MHz (PAL/SECAM). The frequency of blanking level signals is 15.8 MHz (NTSC) and 15.36 MHz (PAL/SECAM). The purpose of using twice frequency modulation is to reduce moiré effects that arise from folded-back lower beat harmonics generated by the modulation process.

The modulator circuit comprising Q14, 15, U19, 20 is a relaxation oscillator whose frequency is determined by the charging rate of capacitors C26 and C61. C26 charges through Q14; C61 charges through Q15. The modulating signal is applied to the bases of Q14, 15. Variations of modulating signal level linearly affect the charging rate of capacitors C26 and C61. This results in the oscillator's output being a linear function of the modulation voltage.

The modulator circuit includes a temperature compensation circuit that minimizes frequency drift due to temperature changes. Pin 11 of U19 provides a temperature-related signal to temperature compensation circuit U20.

One modulator square-wave output is fed off the PWA via transformer T2 and a balanced line to supply modulated rf to the record amplifier, where it is divided by two before application to the record head. Another output of U19 is divided by two by U18 for use by the AFC circuits and is fed off the PWA as E-E rf.

3-20 Automatic Frequency Control

Automatic frequency control (AFC) is applied to the frequency modulator through jumper J1. The AFC signal constrains the output frequency of the modulator to be 15.8 MHz (NTSC) or 15.36 MHz (PAL/SECAM) during the blanking interval. The AFC correction signal is developed by comparing frequency of a reference crystal oscillator running at normal blanking frequency to frequency of the modulator output (divided by two) during the blanking interval. A dc control voltage is developed from any measured frequency differences and is used to correct modulator frequency.

3-21 White Calibrate Pulses

Four white level calibration pulses are injected into the active video of the EE/RF when the WHITE CAL ON/OFF toggle switch on the front of the Modulator PWA is switched to ON. Output of the peak white crystal oscillator is switched onto the EE/RF line during the first four lines after the last post-equalizing pulse. Circuitry comprising U31, 32, U23, U1,U11 decodes sync to generate the correct number of white calibrate pulses and position them in the desired location after the vertical interval.

3-22 Record Drive Adjustment

Sync and video record levels can be controlled via the SYNC REC LEVEL and VIDEO RECORD LEVEL controls on the PWA front edge. When the VPR is in record and the AUTO/MAN switch on the PWA edge is set to MAN, voltage levels at the wipers of potentiometers R326 and R325 are sent to sync and video record drivers on the Record Driver PWA. When the switch is set to AUTO, record current is controlled by the external sync record current signal and the external video record current signal that enter the PWA at pins 51 and 43. These control signals are developed by the A/D converters on the Tape Remaining PWA from data supplied by the control system.

3-23 Input Video Preprocessing

Input video can be preprocessed in the time-base corrector accessory before being recorded on tape. When video preprocessing is selected, and the VPR is in record and EE, switch driver U40-10 closes FET switch U39-1. This applies the video from the cable equalizer to the TBC video input via PWA pin 47 and the VIDEO TO TBC connector on the VPR rear connector panel. This video is time-base-corrected (provided that the NORMAL/BY-PASS switch on the time-base corrector is not in bypass) and looped back into the Modulator PWA via PWA pin 59. The signal is processed through this PWA before being recorded on tape.

3-24 Monitor Selection

The Modulator PWA is the switching point for all VPR-3 system-generated video that can be viewed on the waveform and picture monitors; as such, all monitorable video from the VPR-3 enters this PWA, which contains various switches and line drivers for video monitoring and waveform monitoring. Video signal monitor selection is done by monitor selector decoder U50. Decoder U50 decodes the three data bits supplied to PWA pins 71, 79 and 87 from the Audio Control PWA produces a signal that enables one of four FET switches that route selected video to the waveform and picture monitor line drivers.

3-25 DEMODULATOR PWA

The discussion of Demodulator PWA A2 applies to the following:

- PAL/SECAM, Assembly No. 1467023
- NTSC, PAL-M, Assembly No. 1467020

This PWA demodulates and amplifies one of two incoming rf signals: either off-tape (playback) rf from the equalizer, or electronics-to-electronics (E-E) rf from the modulator. Demodulated video is applied to the Modulator PWA where it can be routed through switches to the VIDEO OUT connector on the VPR-3 rear connector panel. Standard field-rate auto chroma circuitry is located on the Demodulator PWA. This circuitry generates an error signal (AUTO CHROMA ERROR), which is sent to the Equalizer PWA where it controls response characteristics of the cosine equalizer. A block diagram of the Demodulator PWA (with Sync Option PWA) is included in Figure 3-1; also refer to the schematic diagram of the appropriate Demodulator PWA.

The rf that is demodulated (i.e., TAPE or EE) depends on the VTR mode and the TAPE/EE signal at PWA pins 13/14. Selected rf is switched via high-speed diode bridge switch U4 or U7, and then applied to transformer driver Q1 and Q8. Transformer T1 drives a balanced limiter strip comprising U3 and U2 which removes any amplitude modulation from the signal and produces a symmetrical sideband distribution. Temperature compensation and limiter balance adjustment are provided by U5.

3-26 Detector

After limiting, the signal is fed to a balanced pulse-forming detector (Q5-Q6) which produces a narrow pulse for each edge, both positive and negative, of the input signal. A detector balance control is provided to ensure that both the positive and negative edges of the input signal produce exactly the same output pulse width. Output pulses from the detector are fed to an ECL gate (pulse switch) which decreases their rise and fall times and provides differential amplifier and filter driver Q2. A feedback clamp voltage is applied to the emitter circuits of the filter driver (Q2) to ensure the demodulated output blanking level is clamped to 0 Vdc.

Filter driver Q2 drives the video demodulator low-pass filter (L1—L3 and associated components) and the phase equalizer (T2—T4, L4, 7, 8 and associated components). The low-pass filter produces at its output a dc level proportional to the repetition rate of pulses at its input. The resultant varying dc level constitutes the video signal.

3-27 Phase Equalization and Deemphasis

The phase equalizer circuit provides group delay compensation at the filter's upper pass frequencies. From the phase equalizer, the video signal is applied to the deemphasis and frequency response compensation networks in the collector and emitter circuits of Q23. Deemphasis is applied to compensate for the preemphasis inserted by the modulator. Frequency response compensation is required to account for the roll-off inherent in the phase equalizer.

Video is applied to variable gain stage Q33/Q32, which facilitates external gain control via PWA pins 87/88 and switch U34-2, or a unity gain setting depending on the position of switch U34-2. Video is then level-shifted to drive diode bridge switch U33, the output of which supplies two 75Ω line drivers which send the demodulated video signal off the PWA as demod video 1 and demod video 2.

The Demodulator PWA serves several other functions including dropout detection, auto chroma error detection, burst attenuation, sync reinsertion, video level meter driving, demod sync separation, mono/color detection, and burst sample pulse forming.

3-28 Dropout Detection

Dropout rf is brought into the PWA at pins 21/22 and high-pass-filtered at L6 and C65. It is then fed to one input of comparator U14 whose other input is a dc reference (dropout threshold) set by R146. When rf input is above the dropout threshold level, output of comparator U14 is a square wave that successively charges and discharges C61. A TTL head switch signal is brought in at pins 71 and 72. With no dropout present, C61 does not charge to a voltage sufficient to switch comparator U13. Loss of rf below dropout threshold allows C61 to charge to a voltage which trips comparator U13 and produces a TTL dropout pulse at U28/6. This is fed back to a voltage divider at the reference input of comparator U14 to provide hysteresis.

A TTL head switch signal is brought in at pins 71 and 72, and is used to generate a 2µs dropout pulse on each edge of the head switch via exclusive OR U40 and one-shot U29.

The sync reinsert command from PWA pins 33/34 can also generate dropout. The sync reinsert command gates regenerated composite sync, from PWA pins 35/36, to the base of Q15. R127 biases Q15 to provide level adjustment for reinserted sync. Q15 drives Q13 which is on the signal side of diode bridge switch U20.

The dropout signal generated by the sync reinsert command is level-shifted by Q24--Q29, and causes U20 to switch on during sync reinsert time. This permits the dc level representing regenerated sync level to be gated through U20 and into the demod output. At the same time that U20 is switched on by dropout, switch U33 is switched off to prevent video from getting through to the output during dropout.

An rf or headswitch dropout is clamped to a voltage level dependent on video blanking level prior to the dropout, as determined by the sampled voltage on C100 and sync tip level sample voltage stored on C87. These voltages are resistively summed at U21/3 and fed via U21 to control the base of Q16 and thus the level to which a dropout is clamped at the demodulator outputs.

3-29 Burst Attenuation

During burst time, switch U20 is again closed, which switches 200Ω resistor R206 in combination with 200Ω resistor R237 to attenuate burst by 6 db, compensating for the doubling of burst level in the modulation process as required by the Type-C standard. Gated burst is tapped off the resonant circuit in the collector of Q13 and am-detected by U10, and then fed via current amplifier U9 to be level-sampled by U36 and C91. This is ac-coupled and sent off the board as the short time constant, line-by-line, auto chroma error 2 signal, and either sent to the Auto Chroma PWA or summed with auto chroma 1, depending on the configuration of the VTR.

A longer time constant, field-by-field, error signal is sampled by U32 (switched by playback vertical) and stored on C107 to be sent off the board to the Equalizer PWA where equalization is automatically adjusted to make burst a constant amplitude as determined by auto chroma level controls.

Sync amplitude information (as stored at summing junction U21/3) is summed with auto chroma 1 to compensate for overall video level changes being falsely interpreted as an auto chroma. Amplitude of demodulated sync as stored at U21/3 is also used to ensure a predictable slicing level for sync slicer U24, which outputs TTL-level demodulated sync at PWA pins 61/62.

Mono/color detection is performed by comparator U42 which senses burst amplitude. If burst is of insufficient amplitude, comparator U42 stops outputting, which removes trigger pulses from monostable U43. U43/13 stays low, which clears monostable U44, section 2, and monochrome is generated and sent off the PWA at pins 89/90.

3-30 EQUALIZER PWA, A3

A discussion of the Equalizer PWA applies to the following systems:

- Sync, PAL/SECAM, Assembly No. 1467033
- Nonsync, NTSC, PAL-M, Assembly No. 1467230
- Nonsync, PAL/SECAM, Assembly No. 1467233
- Sync, NTSC, PAL-M, Assembly No. 1467030

Equalizer PWA functions include:

- Switching waveforms for the monitoring system
- Playback rf level detection for the three video heads and the record head
- Record head sync demodulation
- AM detection for the AST servo

- Head switching
- Playback cosine equalization of the rf path before it is sent to the Demodulator PWA.

A block diagram of Equalizer PWA 3 (with Sync Option PWA) is included in Figure 3-1. Also refer to the schematic diagram of the appropriate Equalizer PWA.

3-31 RF Inputs

Preamplified off-tape rf from the three video heads is fed from the VTR scanner assembly to the Equalizer PWA. Video playback (AST) head rf enters at pins 75-78, sync playback head rf enters at pins 65-68, and video record head rf enters at pins 55-58. Individual rf signals are fed via matching transformers (T1-T3) and emitter followers (Q26, 18, 15) to high-speed diode bridge switches. External logic signals select which switches are open and which are closed, thus determining which head signal is sent to the equalizer section.

Typically, video playback head rf is used during all playback and video confidence modes. If sync heads are fitted to the VTR, sync rf is selected during the appropriate period of the vertical interval. Record head rf is selected during certain editor and test modes. Selected rf is fed to filter driver Q30, 31 and to the input low-pass filter which has a cut-off frequency of approximately 20 mHz. This filter primarily eliminates induced edit erase signal during edit record mode.

3-32 AGC and Cosine Equalizer

Following the input filter is an AGC amplifier (U33) whose gain is controlled by a signal fed back via an am detector (U22) from the output of the delay-line cosine equalizer portion of the PWA. The familiar cosine equalizer provides transfer characteristics that compensate for the nonideal frequency response characteristics inherent in the record/playback process. A characteristic of the cosine equalizer is its generally tilted cosine-shaped frequency response. Tilt and definition of the cosine shape depend on the level of a dc control voltage applied to the equalizer. Response at a turnover frequency remains constant as control voltage is changed, but frequencies below the turnover frequency are attenuated and frequencies above are boosted. As is essential for virtually distortionless playback, group delay of the cosine equalizer is virtually constant. General shapes of a family of response curves for various control settings are shown in Figure 3-2.

Output of the AGC amplifier is transformer-coupled (T5) to delay-line drivers Q21, 22. DL2 and DL1 are lumped component delay lines approximately 20 ns long. From these there are three rf paths to the equalizer control (echo-adder) circuitry. The three paths are: undelayed rf via O28, 20 ns delayed rf via O27, and 40 ns delayed via Q20. These signals are mixed in echo adder U20 in proportions determined by the equalization control potentiometer setting, or by the signal fed back from the auto chroma system.

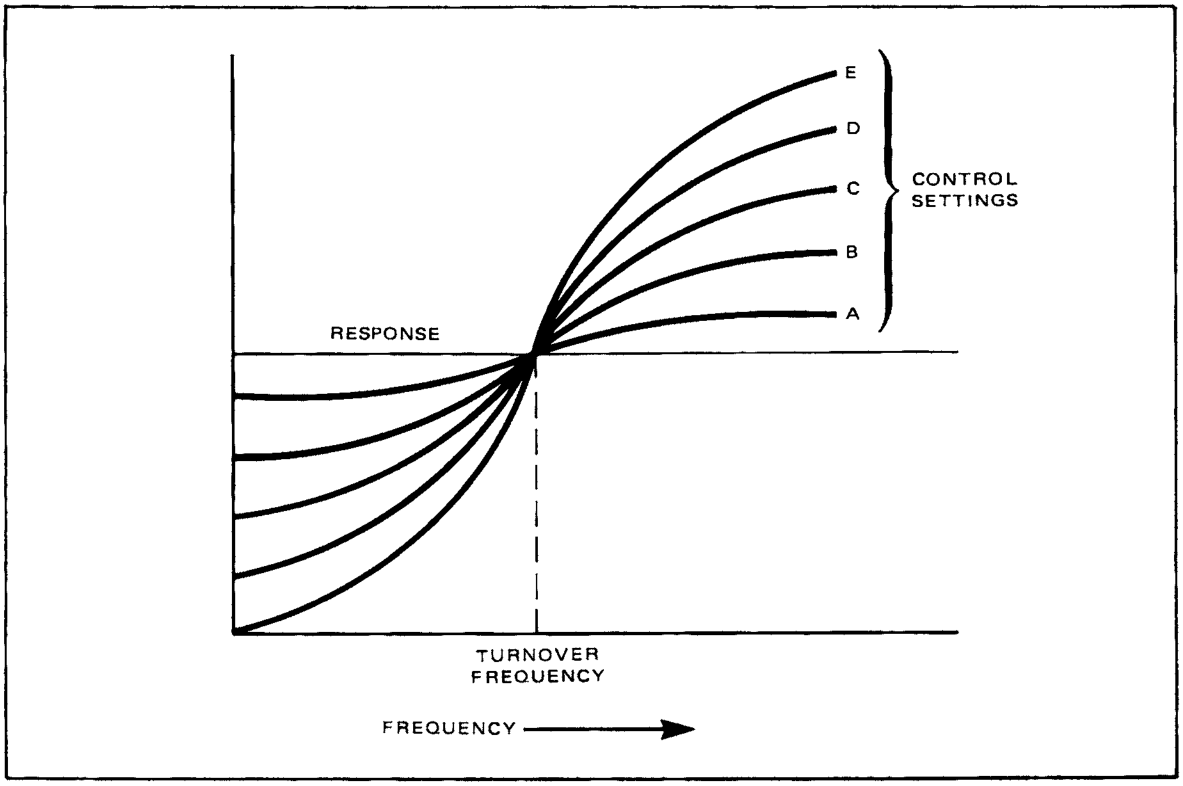

Figure 3-2. Cosine Equalizer Response Characteristics

The equalizer compensates for head and tape response characteristics. It optimizes signal-to-noise characteristics by emphasizing the lower fm sidebands and rolling off the upper fm sidebands. Minimum phase shift is introduced.

3-33 Differential Gain

Control of differential gain is provided by U21 and the tuned circuits in its collector loads. Differential gain may be defined as a change in gain of a reference frequency (normally subcarrier) as the signal goes from black to white. It may be either positive or negative. Negative DG would be a decrease in gain for subcarrier at white level with respect to black level. Positive DG would be an increase in gain for subcarrier at white level with respect to black level. The subjective effect of negative DG on color program material would be a desaturation of high brightness colors (yellow, cyan, green). The subjective effect of positive DG on color program material would be excessive saturation for these same high brightness colors. On played back color bars, negative DG would result in the vectorscope display showing low brightness colors centered in the small boxes while high brightness colors would extend beyond the small boxes.

Output of the cosine equalizer and differential gain control circuitry is fed out of U21 pin 7 to a line driver comprising Q12 and Q16, splitting the rf signal for distribution to three places. One signal is sent to the AGC am detector (U22), thus completing the AGC feedback loop.

Another output is fed to AST am detector U7, the output of which is low-pass filtered and amplified before being sent off the PWA to the AST servo as AST detected rf. The third signal from the line driver feeds the differential phase equalizer comprising Q8, Q9, and tuned circuit L4, C38.

3-34 Differential Phase

Response of the differential phase equalizer is set via operator-adjustable differential phase edge control (R1). Differential phase, or DP, is defined as a change in phase of the subcarrier as the signal goes from black to white. It may be either negative or positive, i.e., lagging or leading. In the NTSC system, the subjective effect of negative (lagging) DP on color program material would be a shift in phase (hue) of high-brightness colors with respect to low-brightness colors, i. e., flesh tones would be shifted toward green. On color bars using the vector position of the vectorscope it would be impossible to center all six colors in the respective centers of the small boxes. When low-brightness colors (blue, red, and magenta) are centered, high-brightness colors (yellow, cyan and green) would not be, and vice versa. In the PAL D system, differential phase would cause a change in saturation. Differential phase errors have little effect in the SECAM system.

Output of the differential phase control circuitry is amplified by U1, one output of which drives emitter follower Q1 which provides rf for the dropout detector on the Demodulator PWA. The other output of U1 feeds the straight line filter L1, 2, 3, etc., which serves to decrease energy in the upper fm sidebands and increase it in the lower fm sidebands resulting in a substantial signal-to-noise improvement.

Q4 and Q5 comprise a 75Ω line driver which sends massaged off-tape rf to the Demodulator PWA. Record rf is picked off the secondary of T1 and sent to two places. One comprises U19, an am detector, and U18, an amplifier, to provide a signal for record head rf level monitoring. Record head rf is also demodulated by U11, U12 and low-pass filter L8, C58, C59 before being sent to sync stripper U13 whose output is record head TTL composite sync, used primarily for edit timing purposes.

3-35 RF Level Monitoring

U38 and U37 provide for rf level monitoring of the video playback head. Similarly, U28 and U27 monitor the rf level of the sync rf head. Because the sync rf track duration is relatively short, output of U27 is sampled and held by switch U25, capacitor C99, and buffer U24 to provide an accurate and steady indication. U23 is a comparator to detect the presence of sufficient sync rf for normal VTR operation. U34 is an rf presence detector for the video rf path.

U35 detects the complete loss of rf during the time the video head passes between the scanner entrance and exit guides. System waveform switching is provided by U6, the selected waveform is output from the PWA at pins 25 and 26. One-shot U15/12 and switch U3/2 insert a 100-µs pulse to 0V in waveform 3 to provide reference frame identification on the waveform monitor. Switches U2, 3, and associated controls, select either manual, automatic, or shuttle control of the equalizer depending on VTR mode.

3-36 VIDEO SIGNAL SYSTEM ALIGNMENT PROCEDURES

Procedures outlined in the paragraphs that follow cover adjustments which do not require special factory test fixtures. Adjustments are not required on a routine basis, and should be performed only if components have been replaced or there are indications of degraded performance when tapes are interchanged. Before performing any adjustments, be sure that the VPR-3 is at an ambient temperature close to its normal operating environment.

3-37 Video Signal System Jumpers

Functions of jumpers used on the PWAs in the video signal system are listed in Table 3-1.

Table 3-1. Video Signal System Jumpers

Jumper	Position	Function
Modulator PWA A1 (1467010)		
J1		Modulator automatic frequency control loop
	A-B	Normal
	A-C	Factory adjustment position; used to set white clip level.
	A-D	Factory adjustment position; used to set black clip level.
	Removed	Remove to set carrier frequency; disconnects automatic frequency control to fm modulator for blanking frequency setup.
J2		Burst channel disable
	A-B	Normal; 2X burst pre-emphasis
	A-C (open)	Test; disconnects burst pre-emphasis
J3		Video 600 ns pre-emphasis inhibit
	A-B	Normal; 600 ns pre-emphasis
	A-C (open)	Test; disconnects pre-emphasis from modulator video input.
J4		Sets time constant of modulator input clamp.
	A-B	Normal; medium time constant
	A-D	Short time constant (use for hum problems)
	A-C	Long time constant (use for noisy signals)
J5		Input feedback clamp setup
	A-B	Normal (on)
	A-C	Test (off)

(Continued next page)

Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Modulator PWA A1 (1467010) (Continued)		
J6		Cable equalization select
	A-B	Normal; use with 8281 coax cable (recommended).
	A-C	Use when RG-59/U (copper clad steel) cable used.
J7		Input amplifier setup
	A-B	Normal; open, differential input is fully differential.
	A-C	Setup position input shorted; use to adjust input differential amplifier balance.
	A-D	High frequency bypass;capacitor to ground, differential input amplifier is differential for low frequencies (such as hum) but not for high frequencies.
	A-E	Defeats differential input; input is unbalanced.
J8, J9		6-MHz low pass filter bypass
	A-B	Normal, no filter
	A-C	Inserts 6-MHz (525) or 7-MHz (625) low pass filter in video path to modulator. Used where excessively high frequencies are present on the video signal such as rf interference or fast rise times present in some computer graphics. Positions of J8 and J9 must match.
J10		Feedback clamp loop disable
	A-B	Normal; clamp on
	A-C	Test; removes video feedback clamp for monitor video to picture monitor for test purposes.
J11		Input amplifier setup
	A-B	Normal; J7 selects grounding normal
	A-C	Test Grounded; Used in test and in single-ended video input mode.

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Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Demodulator PWA A2 (1467020)		
J1, J2		5-MHz low-pass filter setup
J3,	A-B	Normal
	Out	Test; filter alignment
		Not used
		Test jack input to low-pass filter
J9, J11,		5-MHz low-pass filter phase equalizer
J13	A-B	Normal
	Out	Test
J10, J12,		5-MHz low-pass filter setup
J14	Out	Normal
	A-B	For future design
J6, J7		5-MHz low-pass filter setup
	A-B	Normal
	A-C	Test; connects test jack J5 to filter
J8		Back porch clamp disable
	A-B	Normal
	A-C	Test; clamp disabled
J15		Defeat de-emphasis for test
	A-B	Normal
	Out	Test; bypasses demodulator video de-emphasis network.
J16		PAL/SECAM switch
	A-B	Normal
	Out	Secam
J17		Burst de-emphasis
	Out	Normal
	A-B	De-emphasis off
J18		Dropout clamp
	A-B	Normal
	A-C	Disable
J19		Test jack output low- pass filter

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Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Demodulator PWA A2 (1467020) (Continued)		
J20		Burst attenuator
	A-B	Normal
	A-C	Disable
S1	Unity (up)	Normal. Provides a unity calibrated chroma level.
Sync Equalizer PWA A3 (1467030)		
J1		Straight line filter input jack
J2		Straight line filter input
	A-B	Normal
	A-C	Connects filter to J1
J3		Differential phase compensator
	A-B	Normal; on
	A-C	Off
J4		Differential phase ref input
	A-B	Normal, in
	A-C	J7 connected to diff gained output
	B-C	J7 connected to diff phase input
J5		Differential phase compensator
	A-B	Normal; in
	A-C	Off
J6		Differential gained output jack
J7		Differential phase input jack
J8		Equalizer
	A-B	Normal
	Out	Off

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Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Sync Equalizer PWA A3 (1467030) (Continued)		
J9		Differential gain output
	A-B	Normal
	A-C	J6 connected to differential gain output driver
J10		Delay line 2 input jack
J11		AGC
	A-B	Normal
	A-C	Connects J10 to delay line 2 input
J12		AGC output jack
J15		Sync head equalizer control
	A-B	Normal
	A-C	Not used
J16		Input filter jumper
	A-B	Normal
	A-C	J17 connected to input filter
	B-C	J17 connected to video rf
J17		Video rf, input filter jack
J18		Rf output from input filter
J19		E-E tape switching
	A-B	Normal
	A-C	Tape
S1		Auto manual equalize
	Up	Auto equalize
	Down	Manual equalize
S2		E-E tape switch
	Out	Normal
	Depressed	E-E
Nonsync Equalizer PWA A3 (1467030)		
J1		Differential phase compensator
	A-B	Normal on
	A-C	Off

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Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Nonsync Equalizer PWA A3 (1467030) (Continued)		
J2		Straight line filter input jack
J3		Straight line filter input
	A-B	Normal
	A-C	Connects filter to J2
J4		Differential phase rf input
	A-B	Normal in
	A-C	J8 connected to diff gain output
	B-C	J8 connected to diff phase input
J5		Differential phase input jack
J6		Differential gain compensator
	A-B	Normal in
	A-C	Off
J7		Differential gain output
	A-B	Normal
	A-C	J6 connected to differential gain output driver
J8		Differential gain output jack
J9		Equalizer
	A-B	Normal
	Out	Off
J10		E-E tape switching
	A-B	Normal
	A-C	Tape
J11		AGC output
	A-B	Normal
	A-C	Connects J12 to delay line 2 input
J12		Delay line 2 input jack
J13		AGC output jack
J14		Rf output from input filter

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Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Nonsync Equalizer PWA A3 (1467030) (Continued)		
J15		Input filter jumper
	A-B	Normal
	A-C	J16 connected to input filter
	B-C	J16 connected to video rf
J16		Video rf, input filter jack
S1		Auto manual equalize
	Up	Auto equalize
	Down	Manual equalize
S2		EE tape switch
	Out	Normal
	Depressed	EE
Color Framer Detector PWA A5 (1467050)		
J1		90° meter phase change
	A-B	Normal
	A-C	Inverts phase of tape H locked 2 x Fsc into comparator for test purposes.
J2		Subcarrier phase error
	A-B	Normal
	A-C	Test
J3		Reference video switch
	A-B	Normal
	B-C	Connects demodulator video to reference video color frame detector with J8 in A-C position.
	A-C	Connects reference video to tape video path with J4 in A-C position.
J4		Demod video switch
	A-B	Normal
	A-C	Passes reference video through tape video ScHϕ detector, with J3 in A-B position.
J5		Field 1 ident delay
	A-B	Normal
	A-C	Reference field I identification ignored after lockup.

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Table 3-1. Video Signal System Jumpers (Continued)

Jumper	Position	Function
Color Framer Detector PWA A5 (1467050) (Continued)		
J6		Reference subcarrier error voltage switch
	A-B	Normal
	A-C	Used in adjustment of C163 on chroma processor U79.
J7		Subcarrier meter time constant
	A-B	Normal
	A-C	Changes meter to fast time constant for test.
J8		Demod input routing jumper
	A-B	Normal
	A-C	Demod input to ref video input

3-38 Video Signal System Test Points

Signals available at test points provided on the PWAs in the video signal system are described in Table 3-2.

Table 3-2. Video Signal System Test Points

Test Point	Signal
Modulator PWA 1 (NTSC/PAL-M)	
TP1	AFC 7.8 kHz TTL
TP2	Comp sync TTL
TP3	AFC demodulator output
TP4	White cal pulse rf 10 MHz
TP5	Video signal drive to modulator
TP6	AFC rf
TP7	Low passed video
TP8	Black level ref osc 7.9 MHz
TP9	Record rf
TP10	Video filter driver output
TP11	Input video back porch clamp pulse
Modulator PWA 1 (NTSC/PAL-M) (Continued)	
TP12	Variable gain video amplifier output
TP13	Waveform monitor signal
TP14	Waveform monitor clamp
TP15	Clamp pulse waveform monitor
TP16	Monitor video
TP17	Slicer ref on modulator
Demodulator PWA 2 (NTSC)	
TP1	Pulse former output

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Table 3-2. Video Signal System Test Points (Continued)

Test Point	Signal
Demodulator PWA 2 (NTSC) (Continued)	
TP2	Pulse input to low pass filter
TP3	Rf input to limiter
TP4	Back porch clamp
TP5	Dropout ramp
TP6	Burst
TP7	1-MHz low pass video
TP8	Dropout rf
TP9	3.58-MHz burst
TP10	Dropout pulse TTL
TP11	Dropout level threshold
TP12	Auto chroma error
TP13	Burst level
TP14	Sync level
TP15	Not used
TP16	Demod video
TP17	Shuttle TTL
Sync Equalizer PWA 3 (NTSC)	
TP1	Straight line filter input
TP2	Rf level to AST
TP3	Record head rf
TP4	Output of diff gain circuit
TP5	Sync head rf level
TP6	Sync head rf
TP7	Delay line 2 input
TP8	Play head rf
TP9	Rf into diff gain circuit
TP10	Record head rf level
TP11	Play head rf level
Non-Sync Equalizer PWA 3	
TP1	Straight line filter input
TP2	Rf level to AST
TP3	Output diff gain circuit

Test Point	Signal
Non-Sync Equalizer PWA 3 (Continued)	
TP4	Record head rf
TP5	Delay line 2 input
TP6	Rf into diff gain circuit
TP7	Play head rf
TP8	Record head rf level
TP9	Play head rf level
Auto Chroma PWA 4	
TP1	Stored error output
TP2	Chroma error in
Color Framer Detector PWA 5 (NTSC)	
TP1	Flywheel 2X subcarrier
TP2	Sample pulse
TP3	Flywheel subcarrier
TP4	Subcarrier phase
TP5	VCO error voltage
TP6	Off tape subcarrier
TP7	Digital burst
TP8	Subcarrier error ramp
TP9	Subcarrier error to meter
TP10	Comp sync
TP11	Leading edge H sync
TP12	VCO ramp
TP13	Sync gate
TP14	Demod video
TP15	Leading edge H sync
TP16	50% sampled sync
TP17	Sync gate
TP18	Reference video
TP19	50% sync level
TP20	50% sync level
TP21	Reference composite sync
TP22	Demod sync

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Table 3-2. Video Signal System Test Points (Continued)

Test Point	Signal
Color Framer Detector PWA 5 (NTSC) (Continued)	
TP23	Sampled subcarrier
TP24	Line-by-line subcarrier

Test Point	Signal
Color Framer Detector PWA 5 (NTSC) (Continued)	
TP25	Reference subcarrier
TP26	Color frame phase control voltage

3-39 Modulator PWA Adjustments

In the following procedures, the Modulator PWA must be mounted on an extender. Locations of test points, jumpers, and components called out in these procedures are shown in Figure 3-3.

CAUTION

TO PREVENT DAMAGE TO COMPONENTS, ALWAYS TURN OFF POWER BEFORE REMOVING OR REPLACING A PWA IN THE CARD RACK.

3-40 Video Record Head Current Adjustment

STEP 1 Set card-edge OPTIMIZE switch to MAN position.

STEP 2 Thread work tape on transport.

STEP 3 Press PLAY and RECORD simultaneously.

STEP 4 Press monitor switcher RF button on control panel.

STEP 5 Adjust R325 on Modulator PWA for maximum rf as seen on waveform monitor.

3-41 Sync Record Head Current Adjustment

STEP 1 Set card-edge OPTIMIZE switch to MAN position.

STEP 2 Thread work tape on transport.

STEP 3 Press PLAY and RECORD simultaneously.

STEP 4 Press monitor switcher RF button on control panel.

STEP 5 Adjust R326 on Modulator PWA for maximum rf as seen on waveform monitor.

3-42 Monitor Video Cable Equalization

Use the following procedure to adjust monitor amplifier equalization for coaxial cable from VPR-3 monitor output to video monitor.

STEP 1 Place Modulator PWA on extender.

STEP 2 Set jumper J6 to A-C position to adjust equalization for RG-59/U coaxial cable or to A-B position for 8281 coaxial cable.

STEP 3 Connect 2T pulse and bar test signal to video input.

STEP 4 Adjust R211 for best video response.

3-43 Input Amplifier Adjustment

Use this procedure to adjust video input amplifier frequency response and differential balance.

STEP 1 Connect 75% color bar test signal to video input.

STEP 2 Set jumpers J7 and J11 to A-C position.

STEP 3 Connect oscilloscope input to TP12; connect external trigger input to TP11.

STEP 4 Adjust R205 and C139 for minimum signal as seen on oscilloscope. See Figure 3-4.

STEP 5 Return J7 and J11 to A-B position.

STEP 6 Change test signal to sine-squared pulse and bar or split field color bars.

STEP 7 Adjust C115 for minimum bar tilt. See Figure 3-5.

3-44 Input Amplifier DC Offset Adjustment

Use this procedure to adjust dc offset.

STEP 1 Place J5 in A-C position.

STEP 2 Disconnect video input signal.

STEP 3 Adjust R135 for zero volts dc at TP12.

STEP 4 Return J5 to A-B position.

3-45 Video Monitor Gain Calibration

Follow this procedure to set unity gain for video/waveform monitor output.

STEP 1 Connect 1-Vp-p (140 IRE units) signal to video input.

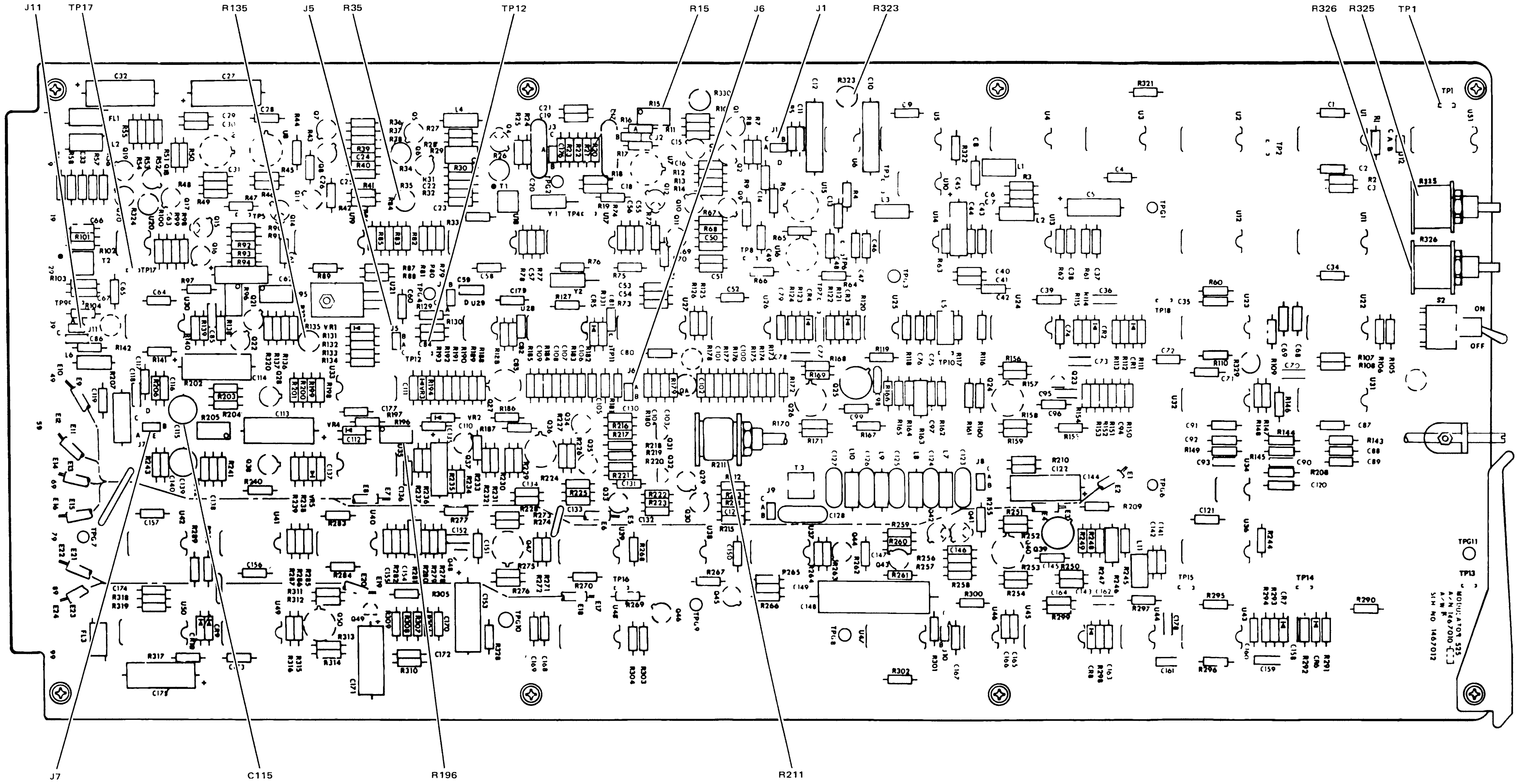
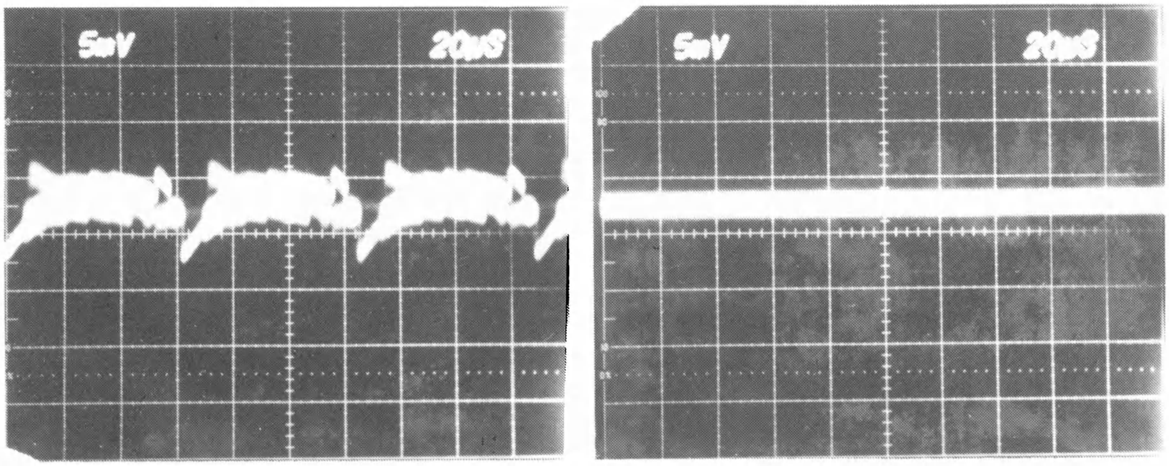


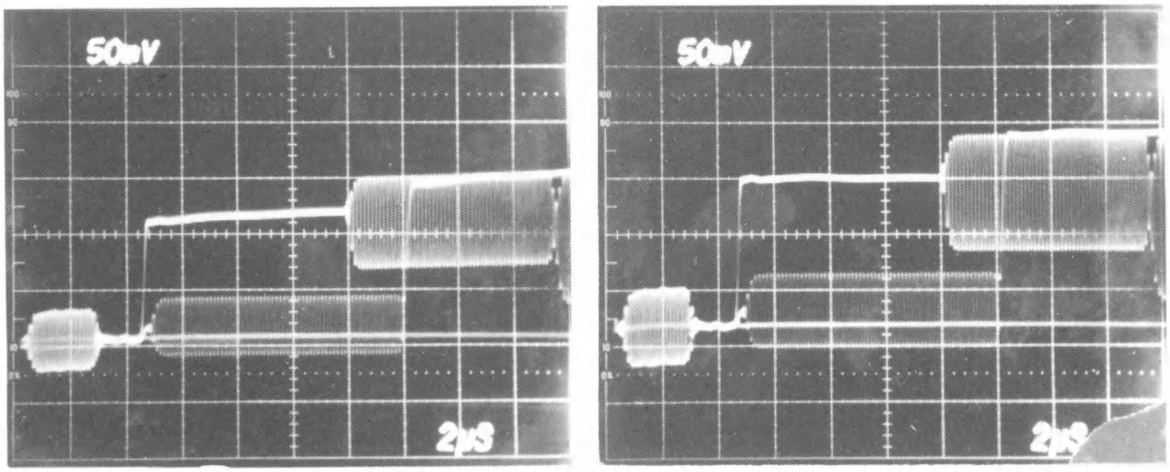
**Figure 3-3.
Modulator PWA Test Point,
Jumper, and Component Locations**



a. R205/C139 MISADJUSTED

b. R205/C139 ADJUSTED PROPERLY

Figure 3-4. Input Differential Amplifier Balance Adjustment



a. C115 MISADJUSTED

b. C115 ADJUSTED PROPERLY

Figure 3-5. Input Differential Amplifier Frequency Response Adjustment

STEP 2 Select VIDEO IN on monitor switcher.

STEP 3 Adjust R196 for 1-Vp-p signal on waveform monitor.

3-46 Modulator Linearity Adjustment

The adjustment contained in this procedure sets modulator linearity.

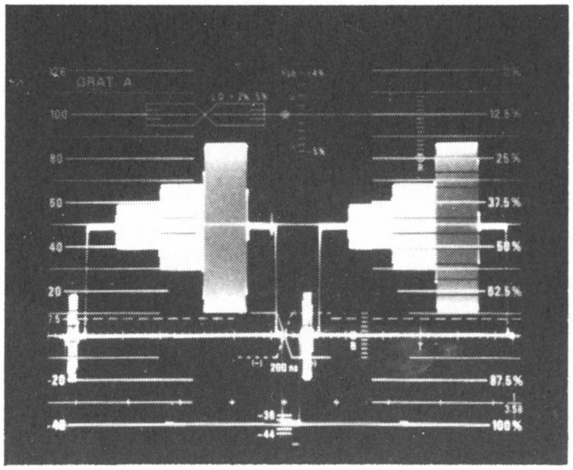
STEP 1 Connect modulated pedestal test signal to video input.

STEP 2 Press monitor switcher DEMOD VID button on control panel.

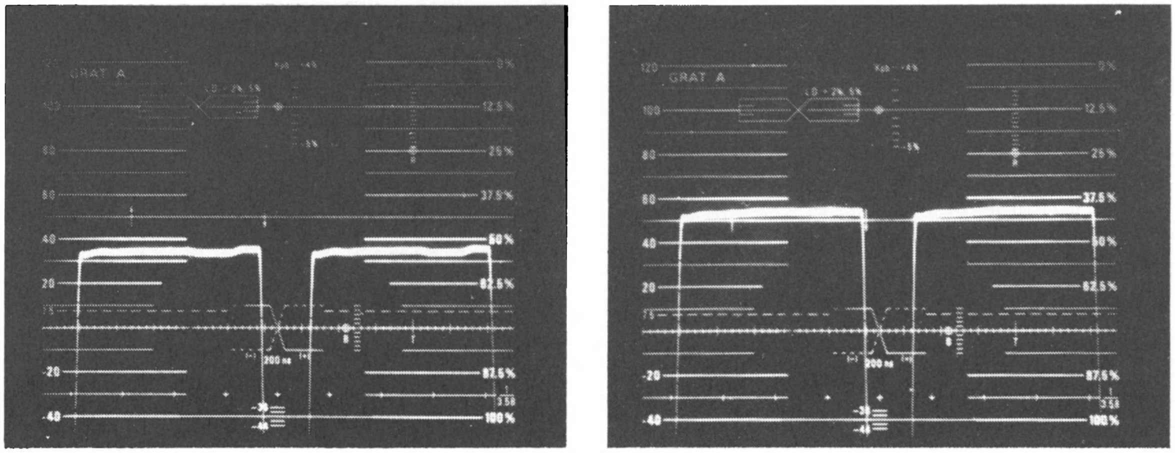
STEP 3 Set scanner off (E-E mode).

STEP 4 Select low-pass response on waveform monitor. Use maximum vertical gain for best resolution.

STEP 5 Adjust R35 for flattest pedestal. See Figure 3-6.



a. MODULATED PEDESTAL SIGNAL



b. R35 MISADJUSTED

c. R35 ADJUSTED PROPERLY

Figure 3-6. Modulator Linearity Adjustment

Note

Linearity adjustment can affect modulator frequency and deviation. Check adjustments given in paragraphs 3-48 and 3-49.

3-47 Modulator Frequency Adjustment

Follow this procedure to set modulator black frequency.

STEP 1 Connect split field color bar test signal to video input.

STEP 2 Connect oscilloscope input to TP17.

STEP 3 Connect oscilloscope external trigger input to TP1.

STEP 4 Adjust R324 for 0 Vdc level.

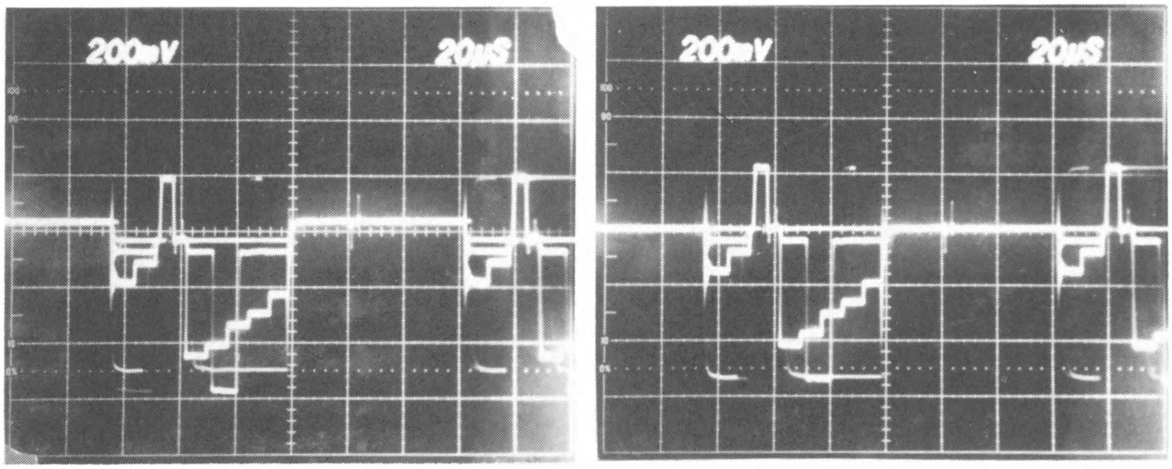
STEP 5 Connect oscilloscope input to TP3.

STEP 6 Remove jumper J1.

STEP 7 Adjust R15 so that video signal blanking level is the same as dc level representing black crystal output. See Figure 3-7.

STEP 8 If blanking level shifts with respect to level during crystal rf period, adjust R323 to match both levels.

STEP 9 Replace J1.



a. R15 MISADJUSTED

b. R15 ADJUSTED PROPERLY

Figure 3-7. Modulator Frequency Adjustment

3-48 Modulator Deviation Adjustment

This procedure outlines steps used to adjust modulator peak white frequency using the built-in crystal calibrator.

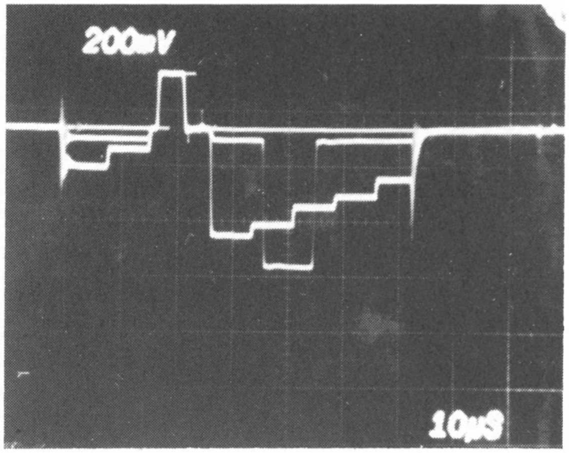
STEP 1 Connect split field color bar test signal to video input.

STEP 2 Connect oscilloscope input to TP3.

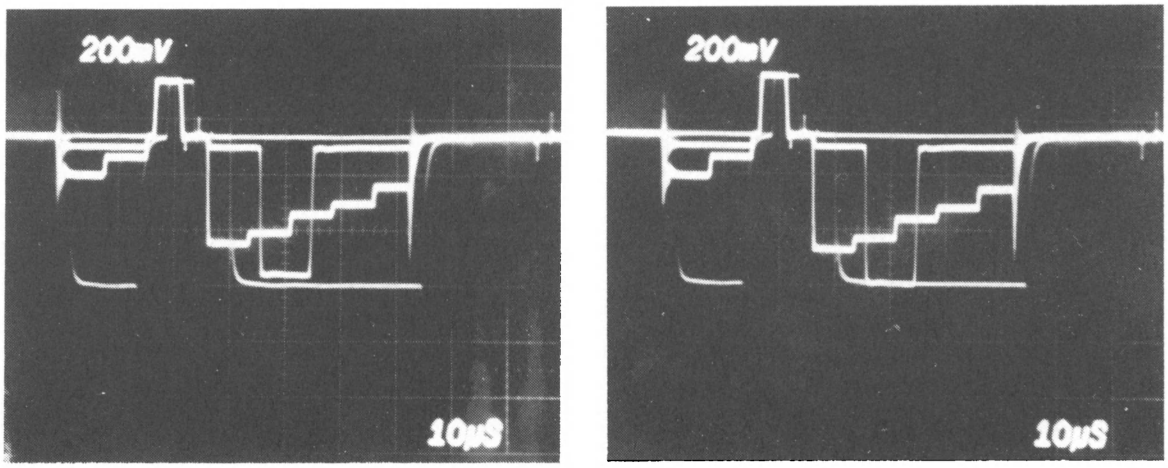
STEP 3 Connect oscilloscope external trigger input to TP1.

STEP 4 With scanner off (E-E mode) set PEAK WHITE CAL switch to ON position.

STEP 5 Adjust R329 to match peak white deviation of test signal to white calibration pulse level. See Figure 3-8.



a. CALIBRATION PULSE OFF



b. R29 MISADJUSTED

c. R29 ADJUSTED PROPERLY

Figure 3-8. Modulator Deviation Adjustment

3-49 Burst Gate Width Adjustment

Use this procedure to set burst gate width.

STEP 1 Connect oscilloscope input to TP18, using internal triggering.

STEP 2 Adjust R329 for pulse width of 3 µs

SECTION 4

CONTROL AND REFERENCE SYSTEM

4-1 GENERAL

This section provides theory of operation and maintenance information for the control and reference system components listed in Table 4-1. This section also contains instructions for control panel assembly removal, and for gaining access to the PWAs within. Also included are troubleshooting suggestions and step-by-step procedures for adjustments which must be made after replacement of certain components.

Table 4-1. Control and Reference System Components

PWA	Assembly Drawing No.	Schematic Diagram No.	Notes
Control PWA	1467200	1467202	Earlier VPR-3s (Version 3 software)
Control PWA	1467203	1467205	Later VPR-3s (Version 4/5 software)
Control Panel Assy, VU	1467500	1467575	VU meters
Control Panel Assy, PPM	1467505	1467575	Peak program meters
Reference Generator PWA	1467220	1467222	NTSC/PAL-M, earlier VPR-3s
Reference Generator PWA	1467217	1467219	PAL/SECAM, earlier VPR-3s
Tape Remaining PWA	1467223	1467225	Earlier VPR-3s only (See paragraph 4-5.)
Reference Generator PWA	1467160	1467162	NTSC/PAL-M, later VPR-3s

(Continued next page)

Table 4-1. Control and Reference System Components (Continued)

PWA	Assembly Drawing No.	Schematic Diagram No.	Notes
Reference Generator PWA	1467163	1467162	PAL/SECAM, later VPR-3s
Color Frame Detector PWA	1467050	1467052	NTSC
Color Frame Detector PWA	1467053	1467055	PAL
Color Frame Detector PWA	1467750	1467752	SECAM
Playback Sync PWA	1467063	1467065	525/60 and 625/50
Playback Sync Preprocessing PWA	1467264	1467263	Accessory

4-2 Conventions

PWAs, integrated circuits, and individual IC pins are designated in the text and on block diagrams as follows. The PWA number is given first, and corresponds to the assigned slot number in the electronics bay. It is followed by the IC reference designation, and a dash number which designates the output pin contact. For example:

20U55-7 = pin 7 of circuit U77 on the Control PWA, which occupies slot 20

Components on the five PWAs within the control panel assembly are designated with 100 to 500 series numbers. Electronics bay slot numbers are not involved, but otherwise the convention is the same.

PWAs in the control and reference system are numbered as shown in Table 4-2.

Table 4-2. PWA Designations

PWA Number	PWA	PWA Number	PWA
5	Color Framer Detector	100	Input/Output
6	Playback Sync	200	Controls
16	Reference Generator	300	LED
19	Tape Remaining	400	Switch Control
20	Control	500	Meter Lamps

4-3 Enhancements

Both hardware and software product enhancements are covered in this section of the manual. When a product enhancement is offered for incorporation into the VPR-3 at the user's option, or a design improvement is phased in without retrofit, both the current and the enhanced design are covered. When enhancements have superseded all previous designs and have been retrofitted into all VPR-3s, only the latest design is covered.

4-4 Control PWA

The Control PWA in delivered VPR-3s may bear either of two part numbers: 1467200 (earlier design), or 1467203 (later design). User requests for software enhancements of earlier design were implemented, and, in so doing, available PROM storage requirements were exceeded. Expanded PROM storage also required a revision in memory map decoding. Enhanced design of the Control PWA (1467203) and Version 4/5 software are offered at the user's option. Therefore, the previous design (1467200), which implements Version 3 software, and the later design are both covered in this manual.

4-5 Reference Generator PWA

The Reference Generator PWA in delivered VPR-3s may bear either of two part numbers. Refer to Table 4-1 for assembly numbers of earlier and later designs. The Reference Generator PWAs of earlier design required a Tape Remaining PWA in electronics bay slot 19. Enhanced hardware design of the Reference Generator PWA includes all logic previously contained on the Tape Remaining PWA. This enhancement was phased into production without retrofit. Therefore, earlier VPR-3s have a Reference Generator PWA of earlier design and a Tape Remaining PWA. Later VPR-3s have a Reference Generator PWA of later design and no Tape Remaining PWA. This section of the manual covers the Reference Generator PWA of earlier design and the Tape Remaining PWA, as well as the Reference Generator PWA of later design.

4-6 THEORY OF OPERATION

The following paragraphs give theory of operation explanations for PWAs in control and reference systems. PWAs are covered in the same order as shown in Table 4-1.

4-7 Control PWA

Control PWAs of both earlier (1467200) and later (1467203) design are discussed in the following subparagraphs. Principal differences between earlier and later Control PWAs are in total PROM storage capacity, memory address decoding, replacement of the discrete nicad battery and battery charging circuits on the earlier design with RAM modules with integral battery, and addition of a DIP switch for added operating features.

Unless otherwise specified, theory of operation information applies to both earlier and later designs. Figure 4-1 is a simplified block diagram of the earlier Control PWA (1467200). Figure 4-2 is a simplified block diagram of the later Control PWA (1467203).

The Control PWA is composed of two Z80 microprocessor (CPU) subsystems: the main CPU subsystem and the remote CPU subsystem. The main CPU automatically implements the initialization routine, a background routine, including continuous diagnostics, and responds to software-initiated interrupts. The main CPU also coordinates the operation of all other VPR-3 systems when responding to manually entered mode change commands. The remote CPU, which is slaved to the main CPU, coordinates bidirectional information exchange between the VPR-3 main CPU and an external bus controller in a serial communication network.

4-8 Main CPU Subsystem

The main CPU subsystem is composed of CPU 20U39, four PROMs 20U41, U49, U61, and U71, three RAMs 20U48, U60, and U70, 4-MHz clock oscillator 20U26, memory map decoders 20U56, U57, and U69, and I/O map decoders 20U47 and U73. The main CPU subsystem is shown on the left-hand side of sheet 1 of Figures 4-1 and 4-2.

4-9 **Bus Structure.** The 8-bit main CPU data bus (D0—D7) is the data read path from the PROMs to the CPU, and the data read/write path between CPU, RAMs, counter/timer circuits (CTCs) 20U50, U62, and U72, PIO 20U42, and port 1 of FIFO 20U68.

Bidirectional data buffer 20U63 provides data linkage between the Control PWA and the other addressable PWAs in the electronics bay. These addressable PWAs are: Audio Control PWA, Reel/Scanner Servo PWA, Control Track/Capstan Servo PWA, Time-Code Reader/Generator PWA, Reference Generator PWA, and (in earlier VPR-3s) Tape Remaining PWA. The buffered I/O data bus on the motherboard is the system data bus (SD0—SD7). The system data bus is also routed to/from the Input/Output PWA and the dot matrix display module in the control panel assembly via ribbon cable.

The 16-bit main CPU address bus is divided into two parallel address bytes: low byte (A0—A7), and high byte (A8—A15). Both address bytes are applied to the PROM and RAM chips for memory address selection, but only the high byte is applied to memory map decoder 20U69 for chip select discrimination. The low address byte is applied to I/O decoders 20U47 and U73 for discrimination between peripheral devices.

Buffer 20U64 provides the address bus linkage between the Control PWA, the addressable PWAs in the electronics bay, and the control panel. The outputs of 20U64 are the low byte system address bus bits (SA0—SA7). Buffers 20U27-3 and -7 link address bits SA8 and SA9 between the CPU address bus and the dot matrix display in the control panel. Both address bus buffers are permanently enabled.

The main CPU service bus signals are composed of a parallel output (Φ) of clock oscillator 20U26, the reset (RES) output 20U17-12, the bus enable (BUSEN) output of 20U16-11, the display strobe to the control panel assembly, and the I/O control outputs of CPU 20U39 (M1, IORQ, MREQ, RD, and WR). The interrupt signal is also on the service bus (see paragraph 4-12).

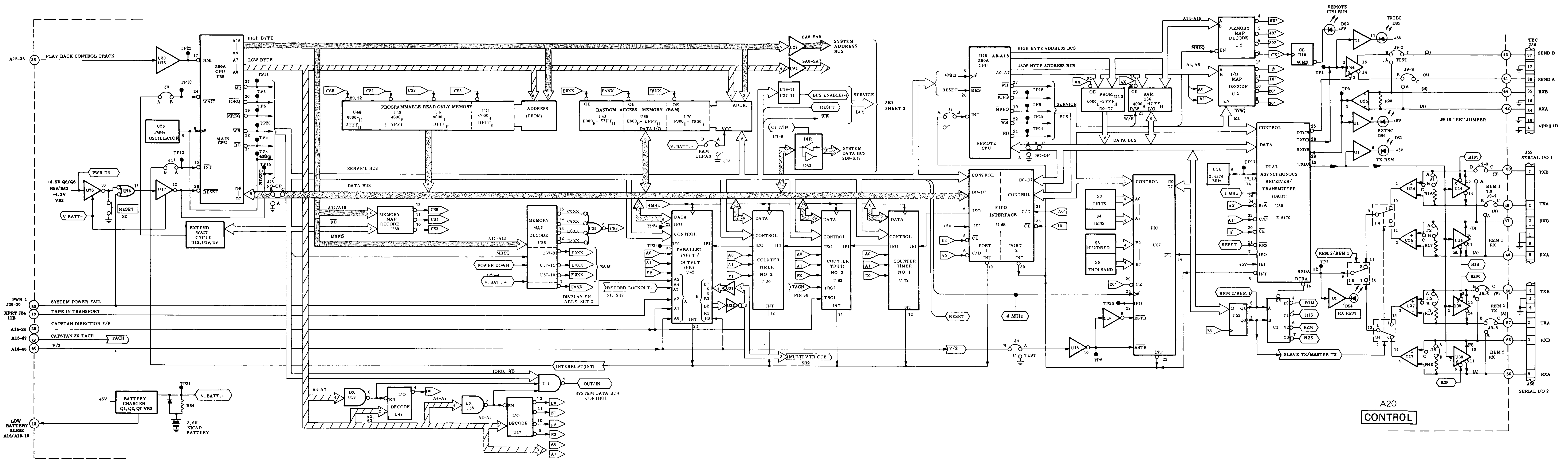
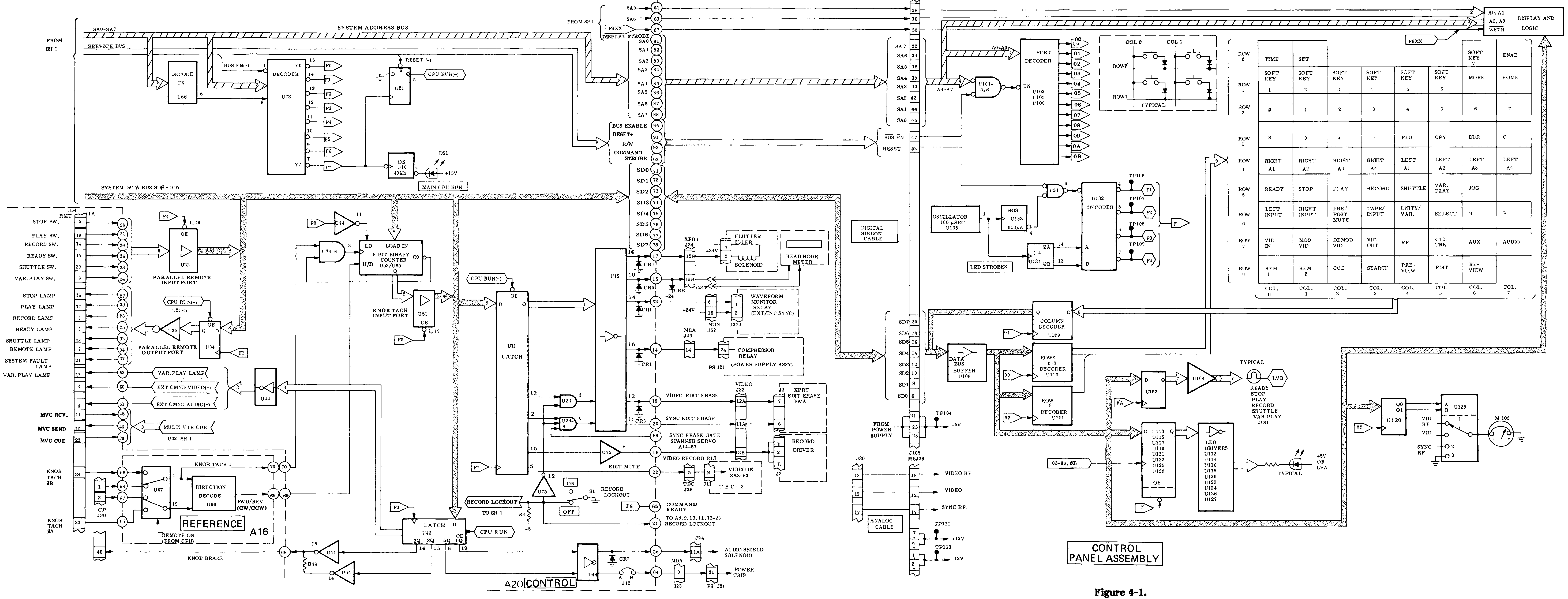


Figure 4-1.
Control PWA (1467200) Block Diagram
(Sheet 1 of 2)



	COL. 0	COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7
ROW 0	TIME	SET					SOFT KEY 7	ENAB
ROW 1	SOFT KEY 1	SOFT KEY 2	SOFT KEY 3	SOFT KEY 4	SOFT KEY 5	SOFT KEY 6	MORE	HOME
ROW 2	0	1	2	3	4	5	6	7
ROW 3	8	9	+	-	FLD	CPY	DUR	C
ROW 4	RIGHT A1	RIGHT A2	RIGHT A3	RIGHT A4	LEFT A1	LEFT A2	LEFT A3	LEFT A4
ROW 5	READY	STOP	PLAY	RECORD	SHUTTLE	VAR. PLAY	JOG	
ROW 6	LEFT INPUT	RIGHT INPUT	PRE/ POST MUTE	TAPE/ INPUT	UNITY/ VAR.	SELECT	R	P
ROW 7	VID IN	MOD VID	DEMOD VID	VID OUT	RF	CTL TRK	AUX	AUDIO
ROW 8	REM 1	REM 2	CUE	SEARCH	PRE-VIEW	EDIT	RE-VIEW	

Figure 4-1.
Control PWA (1467200) Block Diagram
(Sheet 2 of 2)

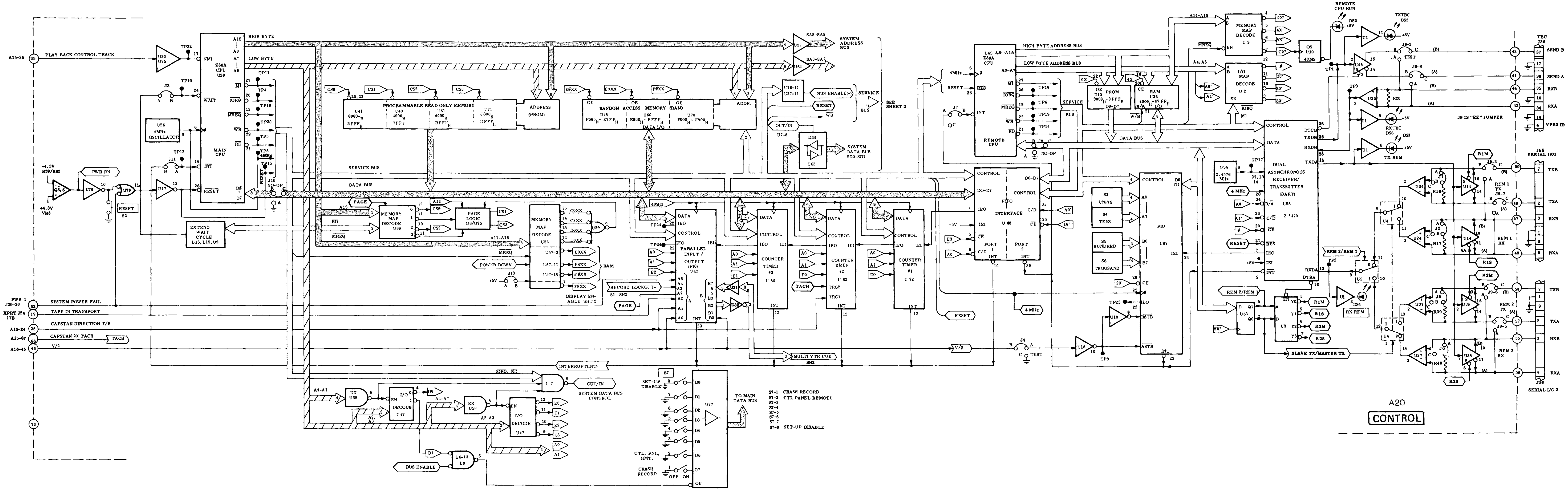
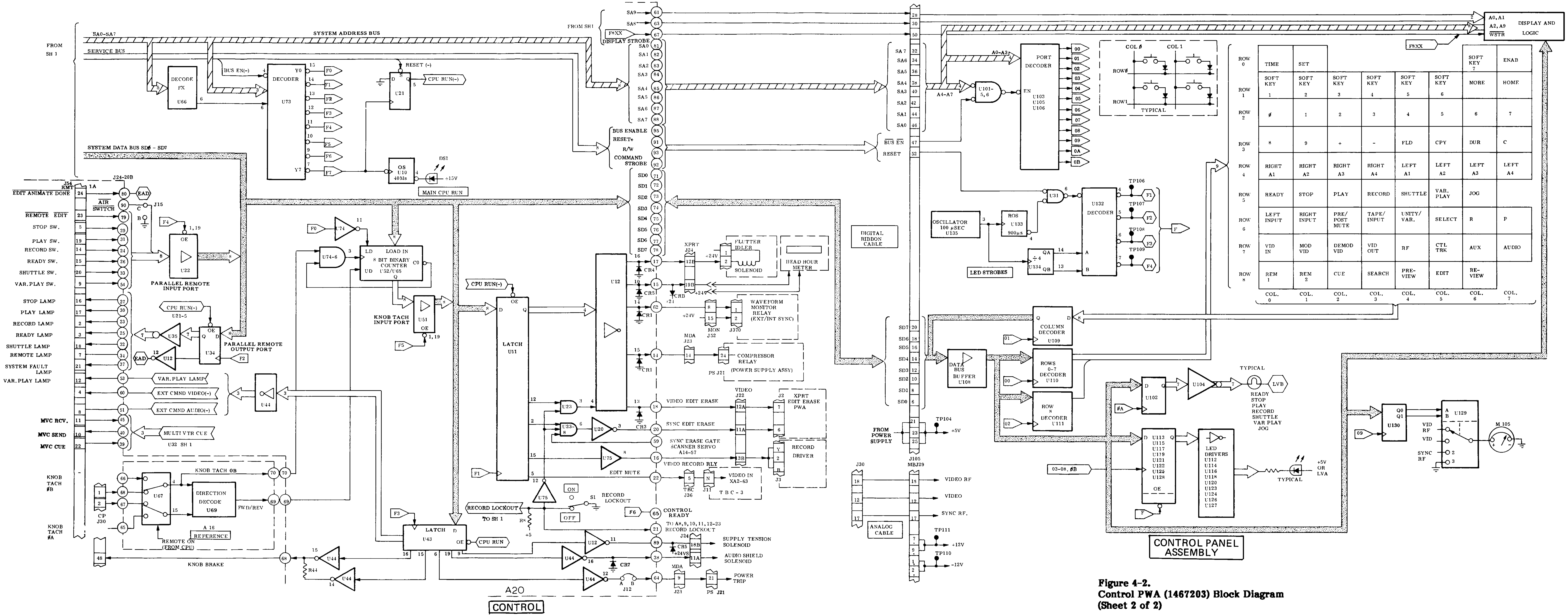


Figure 4-2.
Control PWA (1467203) Block Diagram
(Sheet 1 of 2)



	COL. 0	COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7
ROW 0	TIME	SET					SOFT KEY 7	ENAB
ROW 1	SOFT KEY 1	SOFT KEY 2	SOFT KEY 3	SOFT KEY 4	SOFT KEY 5	SOFT KEY 6	MORE	HOME
ROW 2	∅	1	2	3	4	5	6	7
ROW 3	8	9	+	-	FLD	CPY	DUR	C
ROW 4	RIGHT A1	RIGHT A2	RIGHT A3	RIGHT A4	LEFT A1	LEFT A2	LEFT A3	LEFT A4
ROW 5	READY	STOP	PLAY	RECORD	SHUTTLE	VAR. PLAY	JOG	
ROW 6	LEFT INPUT	RIGHT INPUT	PRE/POST MUTE	TAPE/INPUT	UNITY/VAR.	SELECT	R	P
ROW 7	VID IN	MOD VID	DEMOD VID	VID OUT	RF	CTL TRK	AUX	AUDIO
ROW 8	REM 1	REM 2	CUE	SEARCH	PRE-VIEW	EDIT	RE-VIEW	

Figure 4-2.
Control PWA (1467203) Block Diagram
(Sheet 2 of 2)

Phi (Φ) is a 4-MHz clock pulse for the three CTCs 20U50, U62, and U72, and it is the primary clock input to the remote CPU, 20U45. Read/write (R/W) logic level generator 20U21 is also clocked by Φ.

The reset input to the main CPU can be generated (low) by pressing momentary contact switch 20S2. Reset is also applied automatically when power is applied (or restored). Reset causes the main and remote CPUs to perform their initialization routines. When this is completed, the VPR-3 wakes up in stop mode/standby condition (scanner not running) and the Home menu is displayed.

The display strobe is explained in paragraph 4-47. Functions of other service bus logic levels are explained in the following subparagraphs.

4-10 Memory Addressing. When the main CPU is communicating with memory (or the display), the memory request (MREQ) output of the main CPU is generated (low). MREQ enables address decoders 20U69 and U56 which supply the chip select/output enable outputs to the addressed memory chip. Data transfer direction between the CPU and RAM chips is governed by the logic level of the write (WR) control output of the CPU.

Earlier (1467200) and later (1467203) designs of the Control PWA differ in memory addressing.

The earlier design implements version 3 software which requires 64K bytes of memory. A total of 56K bytes of program information for main CPU 20U39 is stored in PROMs 20U41, U49, U61, and U71. RAMs 20U48, U60, and U70 each provide 2K bytes of data storage. A simplified diagram of the version 3 software memory map is shown in Figure 4-3. The last 2K of memory addresses are used for the control panel dot matrix display. The display is treated as a write-only memory (see paragraph 4-47). Table 4-3 lists the memory address decoder outputs for version 3 software.

Later design of the Control PWA (1467203) supports version 4/5 software. In this design the total storage capacity of the four PROMs is increased from 64K to 128K bytes. A total of 114.6K bytes of program information for main CPU 20U39 is stored in PROMs 20U41, U49, U61, and U71. The capacity of each PROM chip is 32K bytes, and each chip is divided into two 16K-byte pages. The A7 output of PIO 20U42 is added to the address decoding scheme. This is the page select bit which is applied to address decoder 20U69 in place of address bit A14.

The PIO A7 output logic level determines which page in each PROM chip is to be accessed. Gates 20U29-6, 20U6-1, and 20U6-4 implement the expanded address decoding logic. The addressing scheme for PROMs 20U49, U61, and U71 is quite intricate and since it is of academic interest only, the derivations of CS1, CS2, and CS3 are not included in Table 4-4 lists which the memory address decoder outputs for version 4/5 software.

The last 2K of memory addresses are used for the control panel dot matrix display. The display is treated as a "write-only" memory (see paragraph 4-47).

HEX ADDRESS	
0000 3FFF	16K OF PROGRAM IN PROM U41
4000 7FFF	16K OF PROGRAM IN PROM U49
8000 BFFF	16K OF PROGRAM IN PROM U61
C000 DFFF	8K OF PROGRAM IN PROM U71
E000–E7FF	2K OF DATA STORAGE IN RAM U48
E800–EFFF	2K OF DATA STORAGE IN RAM U60
F000–F7FF	2K OF DATA STORAGE IN RAM U70
F800–FFFF	CONTROL PANEL 26 X 256 DISPLAY

Figure 4-3. Main CPU Simplified Memory Map (Control PWA—Version 3 Software)

4-11 I/O Addressing. The main CPU uses the I/O addressing mode when communicating with peripheral devices. Peripherals include the three CTCs, input data buffer, output data latch, PIO, and FIFO chips on the Control PWA as well as other addressable PWAs on the motherboard and the Input/Output PWA in the control panel assembly.

The low byte address bits are time shared between memory address and I/O port/address selection. When memory addresses are selected the low address byte is accompanied by MREQ. When other chips on the Control PWA are accessed, the low address byte is accompanied by IORQ, and when other PWAs are accessed, the low address byte and IORQ are also accompanied by bus enable (BUSEN).

Table 4-3. Main CPU Memory Map (Control PWA 1467200—Version 3 Software)

Address (Hex)	Mne-monic	Source (Decoder)	Function
0000- 3FFF	CS0	20U69-12	Chip select and output enable to PROM 20U41.
4000- 7FFF	CS1	20U69-11	Chip select and output enable to PROM 20U49.
8000- BFFF	CS2	20U69-10	Chip select and output enable to PROM 20U61.
C000- DFFF	CS3	20U29-8 (20U56)	Chip select and output enable to PROM 20U71.
E000- E7FF		20U56-11 (20U57-13)	Output enable to RAM 20U48.
E800- EFFF		20U56-10 (20U57-11)	Output enable to RAM 20 U60.
F000- F7FF		20U56-9 (20U57-10)	Output enable to RAM 20U70.
F800- FFFF	DISPLAY STROBE	20U56-7	Enabling inputs to control panel fluorescent display which is treated as a write-only memory.

When in I/O addressing mode, the main CPU generates I/O request, IORQ (low), and holds machine cycle 1 (M1) high. The M1 output of 20U39, inverted by 20U7-12, and IORQ are applied to gate 20U16-11 which is an AND gate for low inputs. The low AND gate output is the bus enable (BUSEN) logic level which is used to enable the address decoders on the peripheral devices (other PWAs). The word on the low byte address bus completes the enabling of the selected decoder. The three least significant bits on the system address bus are then decoded to provide chip select to (or to enable) the specific device.

The lower order system address byte (SA0—SA7) is presented to decoders 20U66 and U73, shown in the upper left-hand corner of of sheet 2 of Figures 4-1 and 4-2. 20U66 decodes FX, and its output enables 20U73. The F0—F7 outputs of decoder 20U73 clock output data latches (output ports) and enable input data buffers (input ports) for parallel remote and multi-VTR operation, as well as loading and strobing contents of the control knob tach counter.

Table 4-4. Main CPU Memory Map (Control PWA 1467203—Version 4/5 Software

Address (Hex)	Mne-monic	Source (Decoder)	Function
00000- 07FFF	CS0	20U69-12	Chip select and output enable to PROM 20U41.
*	CS1*	20U75-2*	Chip select and output enable to PROM 20U49.
*	CS2	20U69-10	Chip select and output enable to PROM 20U61.
*	CS3*	20U75-4*	Chip select and output enable to PROM 20U71.
XE000- XE7FF		20U56-11 (20U57-3)	Output enable to RAM 20U48.
XE800- XEFFF		20U56-10 (20U57-11)	Output enable to RAM 20U60.
XF000- XF7FF		20U56-9 (20U57-10)	Output enable to RAM 20U70.
XF800- XFFFF	DISPLAY STROBE	20U56-7	Enabling inputs to control panel fluorescent display which is treated as a write-only memory.

Table 4-5 lists low byte I/O address words from CPU 20U39 and I/O address decoder outputs. Low byte addresses to other addressable PWAs not only enable the addressed device, but also enable the bidirectional data buffer on the selected PWA.

Table 4-5. Main CPU (20U39) I/O Map

Address (Hex)	Mne-monic	Source (Decoder)	Function
80–87		20U39	Enables Audio Control PWA decoders 12U85 and 12U74. Also enables bidirectional data buffer 12U63.
90–97		20U39	Enables Reel/Scanner Servo PWA decoders 14U68 and 14U79. Also enables bidirectional data buffer 14U57.
0X		20U39	Enables control panel port decoder U103.

(Continued next page)

Table 4-5. Main CPU (20U39) I/O Map (Continued)

Address (Hex)	Mne-monic	Source (Decoder)	Function
A0–		20U39	Enables Control Track/Capstan Servo PWA decoders 15U96 and 15U107. Also enables bi-directional data buffer 15U70.
B0-B3* (read) B6, B7* (write)		20U39	Enables Reference Generator PWA decoders 19U41 and 19U36. Also enables bi-directional data buffer 19U37.
B0-B7		20U39	Enables Reference Generator PWA decoders 16U85, 16U86, and 16U96. Also enables bi-directional data buffer 16U75.
D0–D3	D0	20U47-4	Chip enable to CTC no. 1, 20U72.
D4–D7		20U47-5	Chip enable to input data buffer 20U77.
E0-E3	E0	20U47-12 (20U58)	Chip enable to CTC no. 2, 20U62.
E4–E7	E1	20U47-11 (20U58)	Chip enable to CTC no. 3, 20U50.
E8–EB	E2	20U47-10 (20U58)	Chip enable to PIO 20U42. **Port A:** D0 V/2 D1 capstan direction D2 tape-in-transport sensor D3 record lockout switch D4 - D5 system power fail

*In earlier VPR-3s the Reference Generator and Tape Remaining PWAs are accessed simultaneously. In later VPR-3s where no Tape Remaining PWA is present, the Reference Generator PWA includes all of the logic previously resident on the Tape Remaining PWA. Refer to Paragraph 4-5.

(Continued next page)

Table 4-5. Main CPU (20U39) I/O Map (Continued)

Address (Hex)	Mne-monic	Source (Decoder)	Function
E8–EB (Cont'd)			**Port B:** D0 V/2 D1 MVC cue (out) D2 MVC send (out) D3 MVC receive (out) D4 - D5 MVC receive (in) D6 MVC send (in) D7 MVC cue (in)
EC–EF	E3 (PS3)	20U47-9 (20U16-6)	Chip enable to port 1 of FIFO 20U68.
F0	F0 (WR0)	20U73-15 (20U74-11)	Enables U/D counter 20U65/U52. Loads information from system data bus into control knob tach counter.
F1	F1	20U73-14	Clocks output data latch 20U11. **Outputs:** D0 flutter idler solenoid D1 compressor relay D2 video record relay D3 video edit erase D4 waveform monitor relay D5 edit mute D6 sync head edit erase D7 head hour meter
F2	F2	20U73-13	Clocks output data latch 20U34/35. **Parallel remote indicator outputs:** D0 STOP D1 PLAY D2 RECORD D3 READY D4 SHUTTLE D5 REMOTE D6 SYSTEM FAULT

(Continued next page)

Table 4-5. Main CPU (20U39) I/O Map (Continued)

Address (Hex)	Mne-monic	Source (Decoder)	Function
F3	F3	20U73-12	Clocks output data latch 20U43/44. **Outputs:** D0 audio shield solenoid D1 knob (speed control) brake D2 knob (speed control) brake D3 VARIABLE PLAY indicator D4 power trip (disconnected by jumper 20J12) D5 external command video D6 external command audio
F4	F4	20U73-11	Enables input data buffer 20U22. **Parallel remote switch inputs:** D0 STOP D1 PLAY D2 RECORD D3 READY D4 SHUTTLE D5 air switch D6 remote edit D7 VARIABLE PLAY
F5	F5	20U73-10	Enables input data buffer 20U51. Writes contents of control knob tach counter on CPU data bus.
F6	F6	20U73-9	CONTROL READY signal to time-code reader/generator.
F7	F7	20U73-7	Triggers one-shot 20U10 which lights CPU RUN indicator 20DS1.

Shift register 20U15 and flip-flops 20U9-5/-9 and the associated gates, clocked by M1 and Φ, produce an extended wait cycle signal at gate 20U19-6. The gate output is applied to the WAIT input of CPU 20U39. I/O ports, memory, and the fluorescent display in particular operate so slowly when compared to the CPU that it is necessary to place the CPU in an extended wait condition after each instruction. The wait cycle interval allows the accessed devices to complete instructions before the CPU program counter continues with the next instruction.

4-12 Main CPU Interrupts

Principal tasks of the main CPU are interrupt-based; relatively little is done in background routine. Two classes of interrupt can break in on the routines of the main CPU: nonmaskable interrupt (NMI), and five prioritized interrupt requests (INT).

4-13 **Nonmaskable Interrupt.** NMI has a higher priority than INT (paragraph 4-14) and is always recognized by the CPU at the end of the current instruction. NMI is negative-going edge triggered by the playback control track (PB CT) signal from the Control Track/Capstan Servo PWA. NMI is generated in all modes in which control track is read (play, variable speed play, shuttle, and cue).

PB CT is a field rate square wave. The negative-going edges which trigger NMI occur at the halfway point within each frame interval.

During tape motion, changes in tape tension effectively change the diameter of the capstan. Also, due to some inevitable tape slippage, the tape may not always be metered correctly by the capstan. NMI causes tape time to be checked, and, if necessary, corrected once per frame. Off-tape control track during play and shuttle modes, or the reference frame (V/2) pulses during record mode are used as timing standard.

In play and shuttle modes off-tape PB CT pulses are received once per frame by the Control PWA via XA20-35. The pulses, which occur in the middle of the frame interval, are buffered and applied to the NMI input of the CPU. If tape time is absolutely correct, NMI is generated halfway between generations of the reference frame interrupt triggered by V/2. Ideally, the modulus (105 or 125) in the tape timer divider will have been counted down to zero when NMI is generated. (The tape timer divider is counter circuit no. 2 in CTC 20U62. See paragraph 4-20.)

The CPU services NMI by looking at the remaining count in the tape timer divider. If the count is zero, no correction is necessary. If the remaining count is some other number, the CPU corrects the count to zero. Thus, any drift in tape time in relation to the control track is corrected within the frame. Any necessary corrections are also furnished to the time-code reader.

In record mode, reference frame (V/2) pulses from the Reference Generator PWA serve as timing standard. The generation of NMI cannot be seen in hardware, but the principles of operation are the same as for generation of NMI in play and shuttle modes.

4-14 **Priority Interrupts.** Prioritized interrupt requests are generated by I/O devices and are recognized by the CPU at the end of the current instruction, provided that the internal software-controlled interrupt enable logic is enabled. The INT input is generated low.

Five of the I/O ports on the Control PWA form a daisy chain interrupt bus. Interrupt priority is determined by the interrupt logic lines, IEI (interrupt enable in) and IEO (interrupt enable out). If the IEI line is high on a peripheral, that device has priority. The interrupting device will pull its IEO line low. This output is routed to the IEI input of the next lower priority device, thus inhibiting the next device in the daisy chain.

CPU 20U39 acknowledges INT by pulling M1 and IORQ low. This allows the interrupting device to place a unique interrupt vector (address) on the system data bus, thus selecting the starting address of a particular interrupt routine. After the CPU has serviced the interrupt, a return to instruction (RETI) command from the CPU resets the interrupting device, thus allowing the next highest priority device to request service. Interrupt priorities are as follows:

- First in/first out register (FIFO) 20U68. This device is the interface between control CPU 20U39 and remote CPU 20U45. See paragraph 4-21.
- CTC no. 1, 20U72: Provides fine timing for erase, record, and play head on/off control at edit entrance and exit points. See paragraph 4-19.
- CTC no. 2, 20U62: Contains tape timer divider for control track correction of tape time and time code. Also interrupts when capstan changes direction. See paragraph 4-20.
- CTC no. 3, 20U50. Same as CTC no. 1. See paragraph 4-19.
- Parallel input/output controller (PIO) 20U42. This device generates an interrupt at a vertical rate. Listings of the logic levels on ports A and B of PIO 20U42 are included in Table 4-5. See paragraph 4-15.

4-15 Parallel I/O Controller

PIO controller 20U42 is a software-programmable, dual port interface between the main CPU and peripheral devices. In this application, port A is programmed as input, and port B is programmed for both input and output. Each port contains separate input and output registers as well as handshake, mode, and interrupt control registers. Chip enable for PIO 20U42 is provided by E2 (E8—EB) from decoder 20U47-10. Main CPU address bit A0 selects port A or B. Address bit A1 is the control/data (C/D) select input which defines the type of information transfer to be made between the CPU and the PIO.

Interrupts generated by the PIO are at level 5 in the priority structure. Within the PIO, port A interrupts have higher priority than those of port B.

4-16 Port A. On the Control PWA of earlier design (1467200), five logic level inputs are presented at port A.

A0 input is reference frame (V/2) from the Reference Generator PWA. V/2 causes the PIO to interrupt the CPU on video field II. The CPU performs the majority of its foreground subroutines in response to this frame rate interrupt. Subroutines include all status checks, housekeeping, and updates to the servo system. A field rate interrupt can be observed at 20TP12 since FIFO 20U68 interrupts the CPU at frame rate on field I.

A1 input is capstan change-of-direction which interrupts the CPU. When coordinating mode change commands which involve capstan change-of-direction, the CPU resets the direction flag in response to this interrupt.

A2 input is the tape-in-transport (TIT) sensor input. The CPU looks at this input on every mode change command.

A3 input is generated (high) when PWA-edge RECORD LOCKOUT switch 20S1 is in ON position. Switch 20S1 is hardware backup for software-controlled lockout of video and all audio channels.

A5 input is the system power fail logic level, which, when generated, sets a flag in the PIO which generates an interrupt to the CPU.

All of the above inputs are included in PIO 20U42, port A on the Control PWA of later design (1467203), and in addition, there is an output at port A7. This is the page select logic level, which in effect adds a 17th address bit to the main CPU address bus. The page select logic level is applied to the 2B input of decoder 20U69.

4-17 **Port B.** Port B of PIO 20U42 is the multi-VTR control (MVC) port. MVC connections with the master (or slave) VPR-3 are made at the REMOTE PARALLEL 1A connector on the I/O connector panel. MVC signals (cue, send, and receive) are listed in Table 4-5.

B0 input is V/2 from the Reference Generator PWA which causes an interrupt to the CPU. The CPU services the interrupt by polling PIO port B for changes in the MVC logic levels.

4-18 Counter/Timer Circuits

There are three counter/timer circuits on the Control PWA: CTC no. 1 is 20U72, CTC no. 2 is 20U62, and CTC no. 3 is 20U50. The CTC has four independent counter/timer channels, composed of 16-bit down counters which can produce an interrupt upon reaching zero. Each counter can be independently triggered by either hardware inputs or by software, and they are clocked by 4-MHz Φ from oscillator 20U26.

Chip enables to CTC nos. 1, 2, and 3 are provided by D0 (D0—D3), E0 (E0—E3), and E1 (E4—E7) respectively, from decoder 20U47. Address bits A0 and A1 on the main CPU address bus are decoded internally to select one of the four counters in each CTC. Interrupts generated by CTC nos. 1, 2, and 3 are at levels 2, 3, and 4 respectively in the priority structure.

4-19 **Edit Timing.** When editing, coarse timing is provided during cue search by comparing the current tape time (or time code) to the edit entrance (or exit) point. When the entrance (or exit) point frame number has been reached, CTC nos. 1 and 3 provide the fine timing for on/off control of erase, play, and record heads within the selected frame. These timers are triggered by the CPU via the data bus.

Manually entered edit entrance and exit points, which are held in RAM storage, provide only coarse timing for the implementation of the video switching involved in editing. The CPU switches the video input path from tape to EE on the vertical interval prior to the entrance point. The CPU then successively loads three values into CTC no. 1: X, Y, and Z milleseconds*. Each value, equivalent to a precise (fine) timing interval, is counted down to zero by 4-MHz Φ. When each interval is counted down to zero, an interrupt is asserted with 250-ns accuracy. The sequence is as follows:

When X ms expire, the first interrupt is generated, and the CPU services the interrupt by switching video erase current to the erase head on the scanner. When Y ms expire, the CPU switches the video record/play relay to RECORD. When Z ms expire, the video record command is sent to the Record Amplifier and Edit Erase PWAs. The above switching operations take place within one vertical interval (one field). Edit erasing begins with field II of the selected entrance point frame.

At the exit point, the reverse switching of video erase and then the record/play relay and record command is timed by CTC no. 1 in the same fashion. The CPU then switches video from EE back to tape. The tape/EE switching is done in response to instructions in firmware. No hardware timing is involved in tape/EE switching.

The same three interrupts are made when entering nonedit record mode. Timing of the switching of video erase, record/play relay, and the record command is done in the same fashion as in edit recording.

When making assemble edit and nonedit recordings, the longitudinal video erase head stack is also switched on. After enough time has elapsed in record mode to allow the start of the recording to travel off the scanner, the edit erase (flying erase) head is switched off and the longitudinal (bulk) video erase head stack is turned on. When making insert edits, this switching operation is not done, and all video erasing is accomplished by the flying erase head.

Three audio edit interrupts provide the precise timing for control of audio erase current and switching of audio record command at auto edit entrance and exit points.

Timing values are loaded in CTC no. 3 on every vertical interval. Audio edit erase interrupt is generated when the first timing value in CTC no. 3 is counted down to zero. The following sequence applies to any of the audio channels. In auto edit mode the audio erase current is turned on four frames in advance of the entrance point. This is necessary because of the physical distance between the audio erase head stack and the audio record/play head stack. Switching on of audio erase is timed by an interrupt from CTC no. 3. At the edit entrance point, another interrupt times generation of the audio record command to the Audio Control PWA at field II of the selected frame. At the exit point, audio erase is turned off and the record command is removed. Audio erase is turned off, and the record command is switched off in response to another interrupt from CTC no. 3.

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* Precise values differ between 525-line and 625-line video standards.

4-20 Tape Time. Counter 2 in CTC no. 2 (20U62) is the tape timer divider. Counter 1 in CTC no. 2 is the tape time modulus corrector. Both are triggered (enabled) by hardware generated inputs.

The tape timer divider is loaded with a time constant value (modulus) during the initialization routine. The modulus is either 105 for 525-line video standards or 125 for 625-line standards. The counter is triggered by TRG2 which is 2H/5 (2X TACH) from the Control Track and Capstan Servo PWA. It is clocked by 4-MHz Φ and the modulus is reloaded into the counter after each time it reaches zero count and produces an interrupt.

At normal play/record speed, 2H/5 = 6293.705 Hz (525) or 6250 Hz (625). Thus, the counter generates interrupts at field rates of 59.94 or 50 Hz. The interrupt rate is directly proportional to the tape speed. For example, at 50X play speed the interrupt rate is 3000 or 2500 Hz. The interrupt tells the CPU when a field of tape has crossed the capstan. The CPU services the interrupt by incrementing or decrementing the tape time held in RAM storage by one field count. The update is also furnished to the time code reader, even if time code is not in use. Whether to increment or decrement is decided by the capstan direction flag which is set by the capstan direction logic level applied at trigger input 1 (TRG1).

The TRG1 input to counter 1 of CTC no. 2 is the capstan direction input. When TRG1 changes logic level, the CTC interrupts the CPU. The CPU services this interrupt in two ways. First, it reverses the direction of tape time count (increment to decrement, or vice versa). Secondly, it adjusts the remaining count in the tape timer divider (counter 2 in CTC no. 2).

The modulus adjustment ensures that field interrupt will remain in sync with the control track by effectively changing the remaining count in the tape timer divider for one frame. The adjusted modulus is transferred into the CTC by the CPU.

Chances are nil that tape direction change will occur precisely coincident with a change in field count. Therefore, the modulus in the tape timer divider will be in some state of incomplete countdown when tape direction is changed. In response to counter 1 of CTC no. 2, the CPU changes the modulus so that it will be counted down to zero (causing field count change) at the same point as if tape direction change had not occurred. This correction is in effect for the one incomplete frame only. Thereafter, the normal modulus (105 or 125) is loaded into the tape timer divider each time it reaches zero count.

4-21 FIFO Interface

First-in/first-out (FIFO) register 20U68 is a dual-port, 128-byte time buffer for asynchronous data communication between main CPU 20U39 and remote CPU 20U45.

Serial data from an external source is received by the serial interface at the RS-422A-specified rate of 38.4 kBd. Incoming data at that rate cannot be presented directly to the main CPU for action. The FIFO provides temporary storage so that the main CPU can be acting in response to received information while additional information is stored in the FIFO time buffer.

FIFO 20U68 can interrupt either the main CPU or the remote CPU, depending on the direction of data transfer. Port 1 of the FIFO is connected to the main CPU data bus, and the port 1 interrupt is routed to the main CPU. Port 2 of the FIFO is connected to the remote CPU data bus, and the port 2 interrupt is routed to the remote CPU. Interrupts from port 1 are at level 1 in the main CPU priority structure. Interrupts from port 2 are at level 2 in the remote CPU priority structure. See paragraph 4-25. Interrupts from the FIFO can be programmed to occur on byte count, byte recognition, and empty or full buffer status. Thus, the FIFO provides some look-ahead capability to the CPUs.

The main CPU can pass data through the FIFO for serial transmission to an external device at any time. However, it can only receive information from the remote CPU via the FIFO when E3 (EC—EF) enables port 1 of the FIFO on a read cycle. In addition, a handshake with the remote device must be completed. Thus, the only time that the main CPU receives remote data is when remote operation has been selected.

4-22 Remote CPU Subsystem

The remote CPU subsystem is composed of CPU 20U45, PROM 20U13, RAM 20U36, address decoder 20U2, and port 2 of FIFO 20U68. The remote CPU subsystem is shown on the right-hand side of sheet 1 of Figures 4-1 and 4-2.

4-23 **Bus Structure.** The 8-bit remote CPU data bus (D0—D7) is the data read path from PROM 20U13 and PIO 20U67 to the CPU, the data read/write path between the CPU, port 2 of FIFO 20U68, DART 20U55, and RAM 20U36, and the data write path from the CPU to output data latch 20U53. The remote CPU exchanges data within its subsystem and with the main CPU via FIFO 20U68. The remote CPU has no direct communication with other PWAs on the system data bus.

The 16-bit remote CPU address bus is also divided into low byte and high byte. When MREQ is asserted, address bits A0—A10 access the 2K bytes in RAM 20U36. When IORQ is asserted, address bits A0—A13 access the 16K bytes in PROM 20U13. Address bits A14 and A15 are decoded to select the PROM, RAM, or output data latch 20U53. Address bits A4 and A5 are decoded to select DART 20U55, FIFO 20U68, of PIO 20U67.

The remote CPU service bus signals are composed of MREQ, IORQ, RD, WR, and M1. The reset (RES) and Φ (clock) inputs are supplied by the main CPU. Reset is applied directly to the RES input of the remote CPU. Φ clocks the CPU and the DART. The interrupt inputs to CPU 20U45 are also on the service bus (see paragraph 4-25). The functions of the other service bus logic levels are explained in the following subparagraphs.

4-24 **Memory and I/O Addressing.** When the remote CPU is communicating with memory (RAM or PROM), memory request (MREQ) output of the remote CPU is generated (low). MREQ enables the memory section of dual address decoder 20U2. Address bits A14 and A15 are decoded by 20U2 to select RAM, PROM, or output data latch 20U53. Decoder 20U2 supplies the chip select/output enable outputs to the addressed memory chip. The direction of data transfer between the CPU and

RAM is governed by the logic level of the write (WR) control output of the CPU. The memory map addresses are listed in Table 4-6.

The remote CPU uses the I/O addressing mode when communicating with the DART, PIO 20U67, or port 2 of the FIFO. When in I/O addressing mode, the remote CPU asserts IORQ (low) and holds M1 high. The M1 output of 20U45 and IORQ (inverted by 20U59-2) are applied to gate 20U8-3. Gate output enables the I/O section of dual decoder 20U2. Decoder 20U2 decodes address bits A4 and A5 to select the DART, PIO, or FIFO port 2. The I/O map addresses are listed in Table 4-6.

4-25 Remote CPU Interrupts

Almost all of the tasks of the remote CPU are interrupt based. Interrupts can be initiated by DART 20U55, PIO 20U67, and port 2 of FIFO 20U68.

Table 4-6. Remote CPU Memory and I/O Maps

Address (Hex)	Mnemonic	Source Decoder)	Function
Memory			
0000-3FFF		20U2-4	Output enable to PROM 20U13.
4000-7FFF		20U2-5	Chip enable to RAM 2U36.
8000-BFFF		20U2-6	Clock to output data latch 20U53. **Outputs:** Q1 remote 1/remote 2 Q2 slave Tx/master Tx
C0000-FFFF		20U2-7	Triggers one-shot 20U10 which lights REMOTE CPU RUN indicator 20DS2.
Input/ Output			
XX00-XX0F	0	20U2-12	Chip enable to DART 20U55.
XX10-XX1F	10	20U2-11	Chip enable to port 2 of FIFO 20U68.
XX20-XX2F	20	20U2-10	Chip enable to PIO 20U67.

The nonmaskable interrupt (NMI) input is not used. All interrupts are via the INT input of CPU 20U45. Interrupts from the DART and PIO are prioritized by connection of DART interrupt enable output (IEO) to the IEI input of the PIO. Interrupts from port 2 of the FIFO are not prioritized by hardware configuration. Refer to paragraph 4-14 for details of daisy-chained interrupt structure.

Remote CPU interrupt priorities are as follows:

1. DART 20U55. See paragraph 4-28.
2. PIO 20U67. See paragraph 4-28.
3. Port 2 of FIFO 20U68. Refer to paragraph 4-21.

4-26 Serial Communication Interface

VPR-3 serial communication interface is shown at the right-hand side of sheet 1 in Figures 4-1 and 4-2.

4-27 __Definition of Terms.__ No attempt is made herein to include all, or even most of the details contained in proposed SMPTE RP 113. The following information, which is paraphrased from RP 113, is included in this manual only to clarify the balance of the theory of operation information.

SMPTE RP 113 defines bus controller, byte, tributary, and word as follows:

Bus Controller:	Each serial data communications system contains one bus controller which supervises all tributaries in the system. Supervision is exercised through the use of the supervisory protocol defined in RP 113.
Byte:	A byte consists of 8 bits of information. Bits used to effect transmission such as byte START, PARITY, or END are not part of the byte.
Tributary:	A tributary transfers messages to and from controlled equipment via the interface system. (In the VPR-3, serial interface circuits on the Control PWA meet the definition.)
Word:	A word consists of a byte and associated bits used to effect transmission such as START, PARITY, or END.

The serial interface of the VPR-3 operates in one of five major operational states: idle, active, poll, select, or group select. These states are defined as follows:

IDLE:	The VPR-3 does not cummunicate in any form. This state is exited only in response to BREAK from the bus controller.
ACTIVE:	The prerequisite state for transition to other operational states. The VPR-3 enters this state whenever BREAK is received.

POLL:	The VPR-3 will transmit a single status byte to the Bus Controller.
SELECT:	A single tributary (device in the serial data communications network) enters a communications mode with the Bus Controller.
GROUP SELECT:	All tributaries (devices) or a selected group of tributaries (devices) enter a communications mode with the Bus Controller.

Supervisory messages supervise the channel and direct the flow of device messages. There are four supervisory messages: break, poll address, select address, and group select address.

BREAK:	BREAK drives all tributaries (devices) to the active state. The BREAK message is composed of spacing for 17 to 20 bit periods, followed by a minimum of 2 bit periods of marking.
ADDR-POLL:	Poll address message drives the addressed device to the poll state.
ADDR-SELECT:	Select address message drives the addressed device to the select state.
GROUP ADDR-SEL:	Group select address message drives a group of devices to the group select state.

Supervisory characters identify communications sequences and provide status information. Supervisory characters are single bytes as shown in Table 4-7.

4-28 VTR Identification and Protocol. At the outset of operation, serial communication between the VPR-3 and the bus controller is verified.

Table 4-7. Supervisory Characters

Supervisory Character	Mnemonic	Name
01	GRP	Group assign
02	STX	Start of message
03	ESC	Escape
04	ACK	Acknowledge
05	NAK	Not acknowledge
06	BSY	Busy
07	RST	Reset
08	SVC	Service request from controlled equipment

The serial interface wakes up in the idle state. In this state no serial communication is possible, but the serial interface will respond to a two-byte address (VTR identification word) from the bus controller. The address, established by the operator, identifies the VPR-3 on the serial communication bus.

Inputs to ports A and B of PIO 20U67 are preset by four thumbwheel switches on the front edge of the Control PWA. The setting of each switch determines a BCD decade output which is applied to the PIO. Thus, a four-digit (decimal) identification number is manually entered. The port A and B strobes (ASTB and BSTB) are V/2 (frame rate) which is applied to the PIO through inverters 20U18-10/-8. The strobes initiate PIO interrupts for VTR identification on video field I. The decimal number entered by the operator is converted to a two-byte address. The bus controller transmits the most significant byte first when communicating with a tributary.

When the serial interface receives the first byte of the address, it takes one step away from idle state and waits for the second byte. If the second byte does not complete the preset identification word, or does not arrive within three frame periods, the serial interface reverts to the idle state. If the second byte does complete the preset identification word, the serial interface transits to the select state. It will stay in select state, and the serial address verification need not be repeated as long as power is on, unless there is a data communication error. If there is an error, the serial interface reverts to the idle state, and the serial communication identification word must be reverified.

The next supervisory character sent by the bus controller will be ESC, and the serial interface will respond with ACK. At this point serial communication has been established.

Supervisory messages to the serial interface are of two types: those which direct the VPR-3 to do something (commands), and those which request the VPR-3 to reply with some specific information (status requests).

The VPR-3 responds to a command with ACK if the command is received properly, and then proceeds to execute the command. If the command is not received properly, the VPR-3 responds with NAK and transits to the idle state.

If there is a communication error in a status request, the VPR-3 responds with NAK and transits to the idle state. The VPR-3 responds to a properly received status request with STX, followed by a byte count of the requested message(s) (not counting STX or the byte count of the checksum at the end), followed by an echo of the status request, followed by the requested data, and terminated with the checksum byte. The byte count includes the echo.

The checksum is the two's complement of the sum (without carry) of the data, including the byte count and echo bytes. Each response is prefaced with the command echo.

Once serial communications have been established, commands from the bus controller to the VPR-3 are in the following form:

STX
Byte count of the message
Message (variable length)
Checksum

Multiple commands or subcommands can be sent in one message as follows:

STX
Byte count of the entire message
Command 1
Command 2
Command N
Checksum

Dual Asynchronous Receiver/Transmitter (DART) 20U55 is the heart of the serial communication interface. The DART contains two independent duplex channels (A and B) and is the interface between the parallel bytes on the remote CPU data bus and the serial I/O lines. Clock pulses for the DART are supplied by crystal oscillator 20U54. The clock frequency is 2.4576 Mhz which provides the RS-422A-specified 38.4KBd serial transmission rate.

Receive or transmit mode and channel selections are made by the control/data and channel A/channel B inputs from remote CPU 20U45. Serial output format depends upon soft key selection of VPR-3, slow-motion controller (SMC), or SMPTE communication protocol.

4-29 Channel A Receive. Data communication on channel A can take place on one of four paths. There are two bidirectional paths on each of two ports for channel A. The ports are designated port 1 (J55) and port 2 (J56). The master/slave status of the VPR-3 in the serial communication network determines which of the two bidirectional paths is enabled within the selected port. The channel, port, and path select instructions are given by remote CPU 20U45 to the DART and output data latch 20U53 via the data bus.

The DTRA output of the DART enables decoder 20U3. The decoded outputs of 20U3 designate whether data is to be transmitted on serial output line 1 (J55) or line 2 (J56) by enabling line drivers 20U14-15/14 and 20U14-10/-11 or by enabling line drivers 20U38-15/-14 and 20U38-10/-11.

When the remote CPU selects channel A via the data bus, the instruction word is applied to output data latch 20U53 which is clocked by 8X' from decoder 20U2-6. At the same time, the data terminal ready A (DTRA) output of the DART enables decoder 20U3 which looks at the Q0 and Q1 outputs of latch 20U53.

The data receiving port and path within channel A are selected as follows. The Q1 output of latch 20U53 (REM 2/REM 1) operates switch 20U5-9, thus selecting serial I/O port 1 or 2 when the VPR-3 is receiving. The Q0 output of latch 20U53 operates switches 20U4-9 and 20U4-12, depending upon the master/slave status of the VPR-3. Thus, when receiving, the serial communication path within the selected port is connected. The received serial data is applied to the receive data channel A (RxDA) input of the DART.

4-30 Channel A Transmit. The data transmission port and path within channel A are selected as follows. The serial output of the DART transmit data channel A (TxDA) at pin 15 is applied in parallel to four line driver circuits 20U14-10/-11, 20U14-14/-15, 20U38-10/-11, and 20U38-14/-15. The enabling inputs to the line drivers are remote port 1 master (R1M), remote port 1 slave (R1S), remote port 2 master (R2M), and remote port 2 slave (R2S). These are outputs of decoder 20U3 which decodes the two LSB of the instruction word. Thus, the active output of 20U3 selects the port and the bidirectional path within the selected port for transmission of serial information. The selection of path depends upon whether the VPR-3 is master or slave.

Two bidirectional paths are provided within each port to accommodate handshake requirements of serial communication protocol. For example, if the VPR-3 is master, and transmitting on port 1, the outgoing information is driven by 20U14-14/-15. The slaved VTR(s) reply with handshake acknowledgements to the VPR-3 via line receiver 20U24-3.

Resistors 20R16, R17, R39, and R40 (jumpers 20J1, J2, J5, and J6), which are across the balanced line inputs of the line receivers, set line impedance. They are 180Ω resistors, which when added to the impedance of the line receiver, provide 91Ω impedance, matching the impedance of RS-422A data transmission cable.

Amber Tx REM and Rx REM LED indicators are lighted by activity on the TxDA and RxDA lines respectively. When serial information is exchanged at 38.4 kBd, these LEDs should be lighted brightly with a slight flicker.

Six jumpers are contained in the dual in-line package (DIP) designated J9 (J9-2, -3, -5, -6, -7, and -8). They are normally in the B-C position on the balanced serial lines. When moved to the B-A position, transmitted information is routed right back into the corresponding line receiver. These jumpers are used in factory test only and are intended to be left in the B-C position.

4-31 Channel B. The channel B port is intended to enable serial communication between the VPR-3 and the TBC. The channel B port is for future development, and TBC serial communications connector J36 is unsupported to date.

The data transmit B (TxDB) line at pin 26 of the DART is routed through line driver 20U46-15/-14 to PWA contacts 41 (SEND A) and 43 (SEND B). SEND A and B compose the balanced line which is RS-422A standard. The channel B data transmit clock (TxCB) from 20U55-15 clocks line driver 20U46-14/-15 and lights TxTBC indicator 20DS6. When receiving on channel B, the balanced inputs are received through PWA contacts 42 (REC A) and 44 (REC B) and are applied to line receiver 20U25-3. The single-ended output of the line receiver is applied to 20U55-8 (RxDB), the channel B receive port.

4-32 Power Up/Down Sequences

The power up/down sequences ensure that values placed in RAM storage when power goes down (and retrieved when power is restored) are valid data.

The power-up sequence is as follows:

1. Application of reset
2. Application of chip and output enable to RAMs
3. Release of reset
4. Retrieval of RAM-stored data

The power-down sequence is as follows:

1. Store current operating data in RAMs
2. Inhibit further access to RAMs
3. Application of reset
4. Turn off chip enable to RAMs

When power is turned on (or restored) the power-up sequence is subject to both digital and analog control. At power-up, system power fail input at Control PWA pin 52 goes low, and output of inverter 20U30-8 goes high. The high output of gate 20U76-11 applies reset to the Control PWA components through inverter 20U17-12 and to the rest of the VPR-3 logic through Control PWA pin 91. At the same time, the rising +5 and +12 Vdc levels are applied to detector 20Q5/Q6/VR3. The detector does not allow the output of 20U76-10 to go low until the +5 Vdc bus reaches +4.8 Vdc. When 20U76-10 goes low, 20Q3 is turned on, and the output of 20U76-4 goes low. This enables RAM output enable gates 20U57-3/-10/-11 and applies chip enable to the RAMs.

On the earlier Control PWA (1467200), the output of 20U76-4 also turns on battery charger transistors 20Q1/Q2, applying voltage to Vdd inputs of the RAMs and to nicad battery 20BT1. On the later Control PWA (1467203), RAM Vcc inputs are tied to the +5 Vdc bus.

Reset remains applied until the 20R60/C57 time constant expires. When the time constant expires, output of gate 20U76-11 goes low, and reset is released (inverter 20U17-12 goes high). Values stored in RAM can then be accessed for completion of the initialization routine.

With power on and stabilized, the inverted system power fail logic level (low) is monitored by the main CPU at PIO 20U42 input port A5. When power is turned off (or fails), the PIO interrupts the main CPU.

When power goes down, the CPU, notified by the PIO, stores the current operating data in RAM before reset is applied. The output of gate 20U76-11 goes high, and the low output of inverter 20U17-12 asserts reset. Chip enable and output enabling inputs to the RAMs are maintained until the time constant of 20R56/R55/C56 expires. When that delay time constant expires, the output of 20U76-4 goes high, turning off the RAM chip and output enable lines.

On the Control PWA of earlier design (1467200), the low output of 20U76-4 also turns off 20Q1/Q2, allowing battery 20BT1 current to power the RAMs.

4-33 Battery Backup

The Control PWA of earlier design (1467200) includes discrete nicad battery 20BT1, battery charger components 20Q1/Q2, 20U76-3, and level detector 20VR2/R63/Q7. The earlier design also includes an analog output (low battery sense) which is furnished to the Tape Remaining PWA for A/D conversion. The Control PWA of later design (1467203) does not have any of these components.

When power comes up, the high output of 20U76-3 turns on 20Q1/Q2/Q7. Battery charging current goes through 20R63 and the forward biased collector/base junction of 20Q7 to the nicad battery. The emitter current of 20Q7 is routed through precision (1%) resistor 20R64 to the Tape Remaining PWA where it is digitized for battery voltage measurement. Detector 20VR2 prevents the battery voltage from going too high if the battery opens up.

On the Control PWA of later design (1467203), volatile 2K-byte RAMs 20U48, U60, and U70 are replaced by nonvolatile RAMs of equal capacity and access times and of superior reliability. The replacement RAMs each contain two internal lithium power cells for protection of stored data. These RAMs normally operate with Vcc of +4.75 to +5.50 Vdc.

The internal logic in RAM constantly monitors Vcc. Should the supply voltage decay, the RAM automatically write-protects itself in the Vcc range between +4.75 and +4.50 Vdc. Once Vcc falls below +4.50 Vdc, all inputs to the RAM become don't-care logic levels, and all outputs become high impedance.

As Vcc falls below approximately +3.0 Vdc, the internal power switching circuit connects one of two lithium cells that supply the power necessary to retain stored data. The decision as to which cell to use is made on the basis of highest cell voltage. The redundant lithium cells are independent rather than parallel to enhance reliability.

During power-up, when Vcc rises above approximately +3.0 Vdc, the power switching circuit connects external Vcc to the RAM and disconnects the lithium cell. As Vcc rises from +4.50 to +4.75 Vdc, the lithium cells are checked. If the voltage in either cell is below +2.0 Vdc, a flag will be set. Normal RAM operation can resume after Vcc exceeds +4.75 Vdc. The flag can be checked on the first write cycle after a power-up. The first write cycle will not be executed if either lithium cell has been depleted, thereby warning of impending data loss.

4-34 Control Panel Assembly

There are two configurations of the control panel assembly: one for VU meters (Ampex Part No. 1467500), and one for peak program meters (Ampex Part No. 1467505). The principal difference is in the four audio record/playback level meter movements, and there are some mechanical differences. However, both control panel configurations contain the same five PWAs, and both configurations are schematically alike. Schematic diagram 1467575 serves both configurations.

4-35 Control Panel Subassemblies

Control panel disassembly instructions for access to the PWAs and replacement of meter and indicator lamps are given in paragraph 4-57. The physical construction of the control panel assembly and locations of the major subassemblies are shown in the diagram which illustrates the disassembly instructions. The major subassemblies of the control panel are listed in Table 4-8.

Table 4-8. Control Panel Subassemblies

Subassembly	Ampex Part No.	Reference Designation Series
Input/Output PWA	1467570	100
Controls PWA	1467583	200
LED PWA	1467566	300
Control Switches PWA	1467590	400
Meter Lamps PWA (3 each)	1467595	500
Display Assembly	1467555	—
Control Knob Assembly	1467530	—

The principal functional areas of the control panel are as follows: row/column matrix arrangement of switches and indicators, LED strobe circuitry, dot matrix display assembly, shuttle control assembly, and analog controls, meters, and indicators. The components on the five PWAs listed in Table 4-8 are merged by function in schematic 1467575 and in the simplified diagram of the control panel assembly. Refer to the right-hand side of sheet 2 of Figures 4-1 and 4-2.

4-36 **Input/Output PWA.** This PWA contains the control panel port decoder, output data latches including the row decoder, input data latch (column decoder), LED drivers, lamp drivers, LED strobe circuits, video/rf/sync meter drive switch, and audio peak indicators. The components on this PWA have reference designations in the 100 series, i.e., U101.

4-37 **Control PWA.** This PWA contains the record/playback, Sc-H, video in, and demod out level controls, and the momentary-contact switches (and associated LED indicators) in rows 2, 3, 4, 6, 7, and 8 of the row/column matrix. Components on this PWA have reference designations in the 200 series, i.e., CR201.

4-38 **LED PWA.** This PWA contains the balance of the LED indicators and all the LED current limiting resistors. It also contains the momentary-contact switches in rows 0 and 1 of the row/column matrix. The components on this PWA have reference designations in the 300 series, i.e., S301.

4-39 **Control Switches PWA.** This PWA contains the six mode control switches (STOP, PLAY, etc.) and the associated incandescent lamp indicators in row 5 of the row/column matrix. The components on this PWA have reference designations in the 400 series, i.e., S401.

4-40 **Meter Lamps PWA.** There are three Meter Lamps PWAs in the control panel. Each contains four incandescent lamps. These PWAs are merely lamp holders for lighting the analog meter scales and pointers. Components on this PWA have reference designations in the 500 series, i.e., DS501.

4-41 **Fluorescent Display.** The main CPU treats the 26 x 256 dot matrix display as a write-only memory of 1024 addresses. Data bits written to an individual address location determine which dots are lighted in the area controlled by that address. See paragraph 4-47 for details.

4-42 **Control Knob.** The control knob governs tape speed and direction in shuttle, variable speed play, and jog modes. The knob also controls tape speed override in play mode. The knob is unplacarded inasmuch as end-stop and detent positions (degrees of rotation) vary in accordance with the active mode. See paragraph 4-48 for details.

4-43 Row/Column Switch Matrix

The control panel is treated as an I/O port with an address range of XX00 through XX0F. When an address in this range is placed on the system address bus and the bus enable line, which identifies I/O data, is generated (low), port decoder U103 is enabled, and the Control PWA is in communication with the control panel. The system address bus is periodically cycled between XX00 and XX0F, and therefore P0 through P12 are sequentially generated by port decoder U103. Functions of the P0—P12 outputs of U103 are listed in Table 4-9.

All control panel switches and corresponding indicators are arranged in an X-Y matrix of nine rows and eight columns. When address XX00 is generated P0 clocks row selector latch U110. The outputs of U110 provide a ground path for switches in one of rows 0 to 7. Address XX02 causes P2 to clock latch U111 which provides a ground path for switches in row 8. To determine whether a switch has been pressed, P1 (XX01) clocks input latch U109. If switch closure has occurred, a logic high is present at the latch input corresponding to the column of the closed switch. Therefore, since only one row is enabled at a time, the main CPU identifies the closed switch by its row/column address.

4-44 Indicator Switching

Beside the switch matrix logic, the only other function of the control panel circuits which can be diagrammed in Figures 4-1 and 4-2 is the control of the panel indicators. Switching and routing of voltages to implement manually entered commands are done under the direction of main CPU 20U39, which recognizes and interprets the manually entered inputs. Switching of voltage to the panel indicators is also done by the main CPU.

4-45 **LED Indicators.** LED indicators are controlled in groups of eight, where each group is an output port. To light an LED indicator, the control CPU first sets the corresponding data bit high. Then the corresponding address (P3—P8, P11, or P12) is generated which clocks the output port latch. The generated data bit, inverted by the latch output buffer (LED driver), thus lights the LED.

Table 4-9. Control Panel Assembly Addresses

Address (hex)	Mne-monic	Source (Decoder)	Function
XX0X		U101-5/6	Enables control panel port decoder U103.
XX00	P0	U103-1	Clocks output data latch (row selector U110). Outputs Q0–Q7 enable (provide ground path for) one of rows 0 to 7.
XX01	P1	U103-2	Clocks input data latch (column selector) U109. Outputs Q0–Q7 put logic high on system data bus in bit position corresponding to closed switch in enabled row.
XX02	P2	U103-3	Clocks output data latch (row selector) U111. Output at U111-2 enables row 8.
XX03	P3	U103-4	Clocks output data latch U113. Outputs of LED driver U112 enable the following indicators: CUE, SEARCH, PREVIEW, EDIT, REVIEW, R, AND P.
XX04	P4	U103-5	Clocks output data latch U117. Outputs of LED driver U116 enable the following REC/INHIB indicators: VIDEO, A1–A4, SYNC, and CNTL TRK.
XX05	P5	U103-6	Clocks output data latch U115. Outputs of LED driver U114 enable the following indicators: R (right) A1–A4, and L (left) A1–A3. U124-15 drives L (left) A4.
XX06	P6	U103-7	Clocks output data latch U122. Outputs of LED driver U123 enable the following indicators: UNITY, VAR, TAPE, INPUT, PREMUTE, POSTMUTE, and L (left) INPUT.
XX07	P7	U103-8	Clocks output data latch U121. Outputs of LED driver U120 enable the following indicators: REC for A1–A4, INHIB for A1–A3. U124-16 drives INHIB indicator for A4.

(Continued next page)

Table 4-9. Control Panel Assembly Addresses (Continued)

Address (hex)	Mnemonic	Source (Decoder)	Function
XX08	P8	U103-9	Clocks output data latch U119. Outputs of LED driver U118 enable the following indicators: REC and INHIB for VIDEO and for CNTL TRK. Also, INSERT, ASSEM, LOCKOUT, AND A1–A4 PEAK indicators.
XX09	P9	U103-10	Clocks output data latch U130. Q0 and Q1 outputs select analog output of selector switch U129 which drives VIDEO RF/VIDEO/SYNC RF meter M105.
XX0A	P10	U103-11	Clocks output data latch U102. Outputs of LED driver U104 enable the following mode indicators: READY, STOP, PLAY, RECORD, SHTL, VAR, and JOG.
XX0B	P11	U103-13	Clocks output data latch U128 Outputs of LED driver U127 enables the following mode indicators: VIDEO IN, MOD VID, DEMOD VID, VIDEO OUT, RF, CNTL TRK, and AUX. U124-11 drives AUDIO indicator.
XX0C	P12	U103-14	Clocks output data latch U125. Outputs of LED driver U126 enables the following mode indicators: REM 1, REM 2, VID RF, VIDEO, SYNC RF, UNCAL, and WRONG F/F.

The F1—F4 outputs of decoder U132 enable the eight LED output port latches, two at a time. This effectively switches +12 Vdc (LVA) to the lighted LEDs on a 25% duty cycle.

Timer U135 clocks 2-bit counter U134 while retriggering one-shot U133. The one-shot output keeps gate U131 enabled, which, in turn , keeps decoder U132 enabled. Binary outputs of counter U134 are decoded by U132, thereby sequentially producing F1 through F4. Each output of U132 enables two LED output port latches.

4-46 Lamp Indicators. The seven incandescent lamp indicators are controlled in similar fashion by output latch U102 and lamp driver U104. Port latch U102 is clocked by P10 from port decoder U103. The +12 Vdc power (LVB) to the lamp indicators is not multiplexed.

4-47 Fluorescent Display

The display assembly is composed of a display logic PWA, a display driver PWA, and a 26 x 256 dot matrix fluorescent display module. Character generation information (display area addresses) is stored in PROM 20U71 on the Control PWA. The schematic diagram of the display assembly (not manufactured by Ampex) is shown in Appendix B of the VPR-3 parts lists and schematics manual. Information given here is limited to interface between the Control PWA and the display assembly.

All connections between the Control PWA and the fluorescent display are made via two ribbon cables: one from the motherboard to the control panel assembly (J105), and one from the control panel assembly to the display (J101). None of the five PWAs in the control panel is involved in the operation of the fluorescent display.

The logic PWA in the display assembly contains the display power supply. The only power connection required from the VPR-3 is a +5-Vdc supply.

System address bus bits SA0—SA9, the system data bus (SD0—SD7), and the display strobe (WSTR) are supplied to the display assembly. The display does not return any acknowledgement signals to the control system. The Control PWA does not make use of the two scrolling (right and left) or blanking inputs, nor of the SYNC (acknowledgement) output of the display assembly logic.

The control system treats the display as a write-only memory. When the display (or write) strobe is generated, the address specified by SA0—SA9 and the byte on the system data bus are clocked into output data latches on the display logic PWA. The data byte determines which dots in the display matrix are to be lighted in the matrix area (character) designated by the latched address.

4-48 Control Knob Assembly

The control knob assembly includes a two-phase tach disk which indicates degree of shaft rotation, and a magnetic brake, which, on command, seizes the shaft and prevents rotation.

The phase A and B tach outputs are routed to the Reference Generator PWA where a tach processor determines direction of shaft rotation. The phase B tach and direction logic level are buffered and routed to the Control PWA. The Control PWA controls application of the knob brake. Depending upon the active mode and degree of knob rotation, the main CPU causes the brake to be applied when knob rotation end stops have been reached. Control knob circuits are shown on the left-hand side of sheet 2 of Figures 4-1 and 4-2.

4-49 **Knob Tach.** The 8-bit binary up/down counter composed of 20U52/U65 is clocked by knob tach pulses through gate 20U74-6 which is enabled at any time the counter does not contain a count of 255 when counting up or 000 when counting down. The counter is preset (loaded) from the system data bus when F0 is generated by decoder 20U73. F0 is generated when shuttle, variable speed play, or jog mode is entered. F0 is also generated when tape speed override (TSO) is selected. Count direction (up/down) is controlled by knob rotation direction: clockwise = count up, counterclockwise = count down.

The counter is interrogated at frame rate by generation of F5 which enables input data buffer 20U51. This is part of the frame rate interrupt routine. The main CPU is thus continually made aware of control knob position. The CPU updates the capstan servo in accordance with any change in knob position. At terminal counts of 000 and 255 gate 20U74-6 is inhibited and clock inputs are disabled. No further change of speed commands are sent to the capstan servo, and knob brake is applied.

4-50 **Knob Brake.** Knob brake command is generated by output data latch 20U43. When 20U43 is clocked by F3 from decoder 20U73, system data bus bits SD1 and SD2 are inverted, summed, and routed via pin 48 to the knob brake solenoid. The solenoid applies +24 Vdc to the knob brake.

The knob brake operates on magnetic eddy current principle. Brake control output at pin 68 is a logic high. The actuated brake solenoid applies +24 Vdc to the knob brake. The brake, which surrounds the control knob shaft, is filled with iron filings. The output of the solenoid creates a magnetic field in the knob brake, and the iron filings seize the steel shaft. The rotational points of brake and detent application depend upon the current mode of VPR-3 operation.

4-51 **Control Knob Operation.** The control knob is activated when shuttle, variable speed play, or jog mode is entered. The knob is also active when tape speed override (TSO) is enabled by soft key selection.

In jog mode, the control knob has no end stops and no detents. Four revolutions of the knob cause one revolution of the capstan in either forward (clockwise) or reverse (counterclockwise). The number of useful rotations of the knob is limited only by the length of the tape on the transport.

When TSO is selected (part of variable speed operation menu), knob brake and detent features are used. In TSO operation, the control knob enables the operator to slow down or speed up normal play mode by 511 seconds per hour. When the TSO soft key is pressed, a half-scale count of 128 is loaded into 8-bit knob brake counter 20U52/U65. The current knob position is thus established as the position for no tape speed variation.

If the knob is rotated clockwise, knob tach pulses cause counter 20U52/U65 to count upward and tape speed is increased. Playback time with respect to normal play speed is reduced. The reduction in playback time is shown on the fluorescent display, i.e., -120 seconds. If the knob is rotated clockwise, the knob tach counter counts downward, tape speed is decreased, playback time is increased, and the increased time in seconds per hour is displayed. Each knob tach pulse equals four seconds per hour*. Knob brake is applied at maximum indications of ±511s.

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* On VPR-3s equipped with a Reference Generator PWA of later design (1467160 or 1467163), placement of jumper 16J6 provides a selection of fast or slow jog speed. See Table 4-12, paragraph 4-77.

A detent is generated at the point of zero TSO. A detent is caused by application of the brake only at the half-scale point of the knob tach counter (count of 128). The detent (brake) is overcome by manual rotation of the knob. When TSO is deselected, the knob position, represented by the count in 20U52/U65, is placed in RAM storage. Thus, TSO value is immediately recovered when TSO operation is re-entered. See Figure 4-4. Contents of the knob tach counter are shown in parentheses.

Control knob operation in shuttle mode is very similar. When shuttle mode is entered, a half-scale count of 128 is loaded into knob tach counter 20U52/U65. The current knob position is thus established as the analog of zero tape speed, and a detent is set at that point. As in TSO operation, end stops (knob brake) are applied at the maximum clockwise and counterclockwise positions which equal maximum forward and reverse shuttle speeds of +50X play and -50X play. When shuttle mode is exited, the contents of the knob tach counter are not transferred to RAM storage. See Figure 4-4.

Control knob operation in variable speed play mode involves not only two end stops, but also the establishment of three detented points. When variable speed play mode is entered, the knob tach counter is loaded with a count of 064. The current knob position is thus established as variable speed STOP position which is detented. As shown in Figure 4-4, two detents are also established at knob positions corresponding to knob tach counter contents of 160 (normal play speed) and 224 (2X play speed). End stops are set at the terminal counts of the knob tach counter: 000 (-1X play) and 255 (3X play).

Clockwise rotation of the control knob clocks the counter upward, and the main CPU continually issues increase speed commands to the capstan servo as the counter contents increase toward the maximum count of 255 (3X play). The degree of knob rotation is directly proportional to tape speed, but the proportion is not linear. The counter increases from 064 to 160 between STOP and PLAY, from 160 to 224 between PLAY and 2X PLAY, and from 224 to 255 between 2X PLAY and 3X PLAY. Thus, each count increases in tape speed value as 3X PLAY position (255) is approached.

Counterclockwise rotation of the control knob clocks the knob tach counter downward, and reverse tape speed increases as the terminal count of 000 is approached. A count of 000 at the maximum counterclockwise position of the control knob commands normal play speed in reverse.

When variable speed play mode is exited (i.e., to stop mode), the contents of the knob tach counter are transferred to RAM storage. When variable speed play mode is reentered, the variable speed value is recalled from memory and reloaded into the knob tach counter. Thus, the same variable tape speed is immediately achieved. TSO value is stored and recalled in the same fashion. This is not done when exiting and re-entering shuttle mode inasmuch as the shuttle value could have been near ±50X play speed when shuttle mode was exited. Waking up in shuttle mode at those speeds could cause great inconvenience.

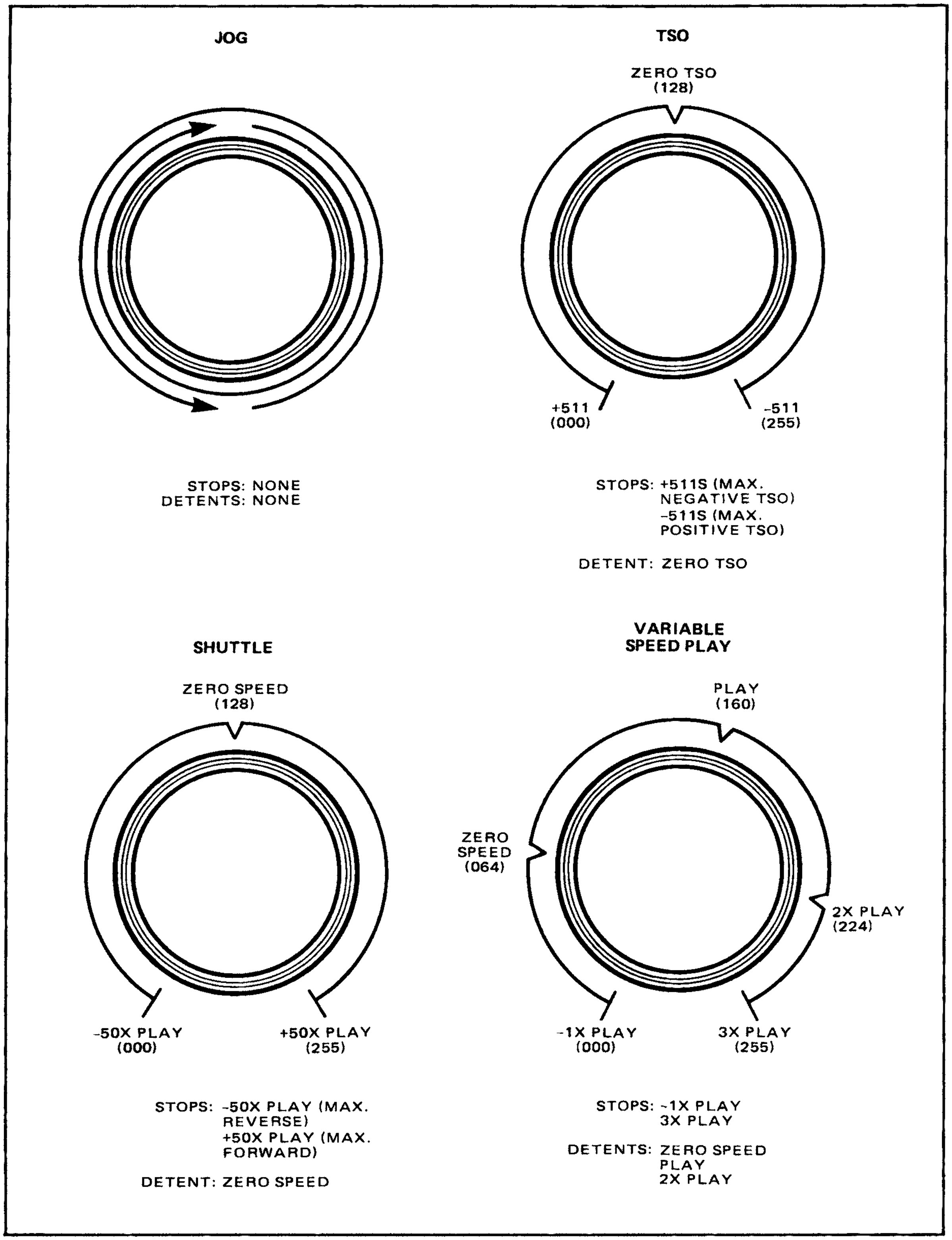


Figure 4-4. Control Knob Stops and Detents

4-52 Analog Controls/Indicators

The outputs of the analog controls and driving inputs to the analog indicators on the control panel are covered in the video and audio system sections of this manual (Section 3 and 7). The logic associated with the audio peak indicators and the video and Sc-H meters is part of the control system.

4-53 **Audio Peak Indicators.** The four audio channel PEAK indicators (CR301, 308, 312, and 316) are each controlled by an analog level from one of the four Audio PWAs. When an audio level reaches peak value (+8 VU), the peak signal level is driven to 0V. This produces a ground path for +12 Vdc (LVA), and the corresponding PEAK LED indicator is lighted.

The Q7 output of output data latch U119 turns on N-channel FET Q102. When on, Q102 forward biases diodes CR103—CR106. A ground path is provided for the high output at U119-12, and all four PEAK indicators are lighted at the same time. Thus, Q102 provides a means of testing the audio PEAK indicators without involving outputs from the Audio PWAs.

4-54 **Meter Drive Switch.** The VIDEO RF/VIDEO/SYNC RF meter (M105) is driven by the selected output of meter drive switch U129. Successive depressions of the SELECT switch on the control panel advance the two outputs of the meter drive switch through the simple binary progression 00, 01, 10. The logic levels at the meter drive switch outputs are sampled when P9 from port decoder U103 clocks output data latch U130. Thus, the states of data bus bits D0 and D1 select either the video rf, video, or sync rf input to the switch as the meter drive output.

4-55 MAINTENANCE ACCESS

With exception of the five PWAs within the control panel assembly, all PWAs in the control and reference system are located in the electronics bay. Removal of a PWA from the electronics bay and installation on an extender for access to components in the field of the PWA require no special instructions. However, it is important to mention that power must be turned off before removing or reinstalling a PWA.

4-56 Input/Output PWA

Access to components and test points on the Input/Output PWA in the control panel assembly can be gained without removing the control panel from the VPR-3. Components on the Input/Output PWA are made accessible for testing and observation of waveforms as follows:

STEP 1 Unlatch control panel assembly by pulling two latches forward. See Figure 4-5.

Note

The latches located in the top edge of the control panel assembly have two planes of motion. When latches are pulled forward, the control panel is unlatched from the VPR-3 frame. When latches are pressed sideways (toward center of control panel) the control panel assembly is disengaged from detents in the control panel bracket.

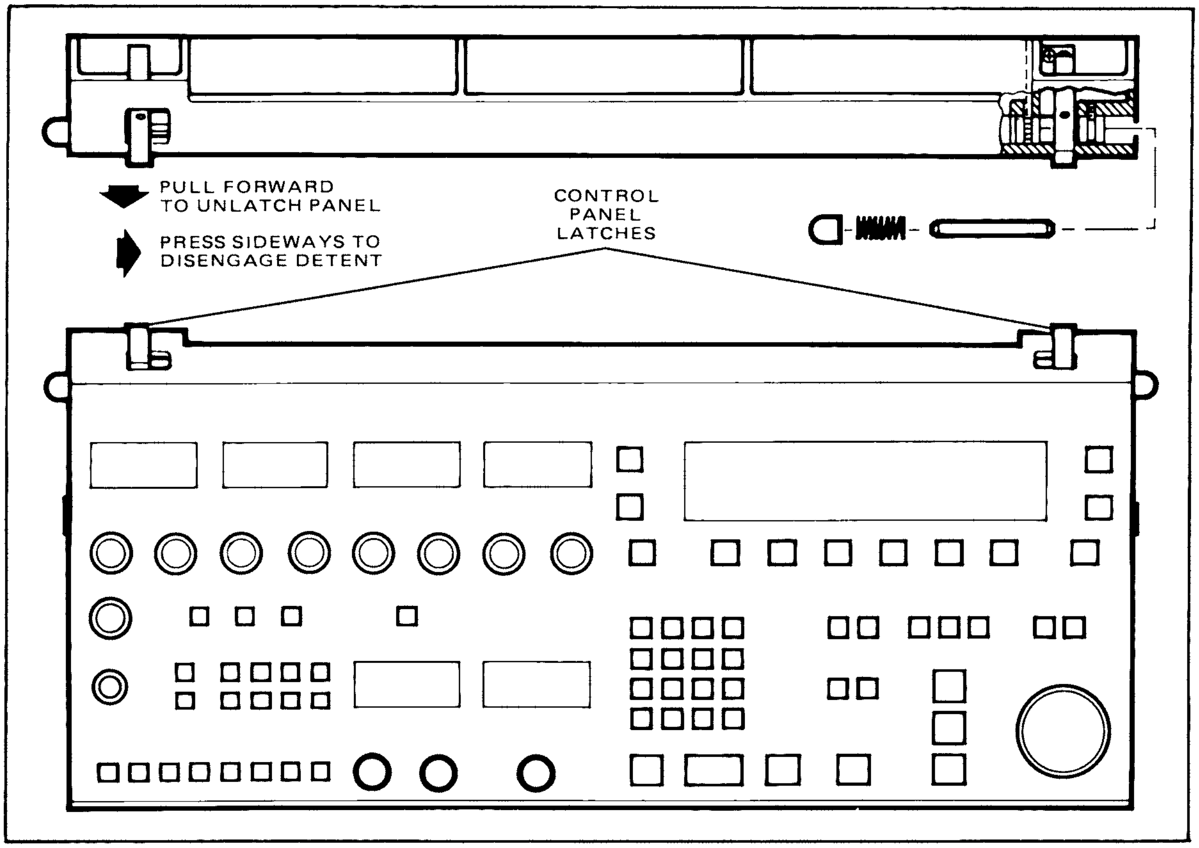

PULL FORWARD TO UNLATCH PANEL
PRESS SIDEWAYS TO DISENGAGE DETENT
CONTROL PANEL LATCHES

Figure 4-5. Control Panel Latches

STEP 2 Pull top edge of control panel (and control panel bracket) forward. See Figure 4-6.

STEP 3 Press right-hand latch to the left, and, at the same time, press left-hand latch to the right, thus disengaging control panel detent pins from control panel bracket. Allow control panel assembly to hang vertically in the bracket as shown in Figure 4-7.

STEP 4 Rotate top edge of control panel backward until detent pins engage bracket as shown in Figure 4-8.

STEP 5 Carefully raise control panel bracket (and panel) as close to stowed position as possible. Refer to Figure 4-9.

STEP 6 With VPR-3 power off, detach two ribbon cable connectors at rear of control panel assembly.

STEP 7 Remove six screws which secure rear cover of control panel assembly and detach cover. Refer to Figure 4-9.

STEP 8 Reconnect two ribbon cables at rear of control panel assembly.

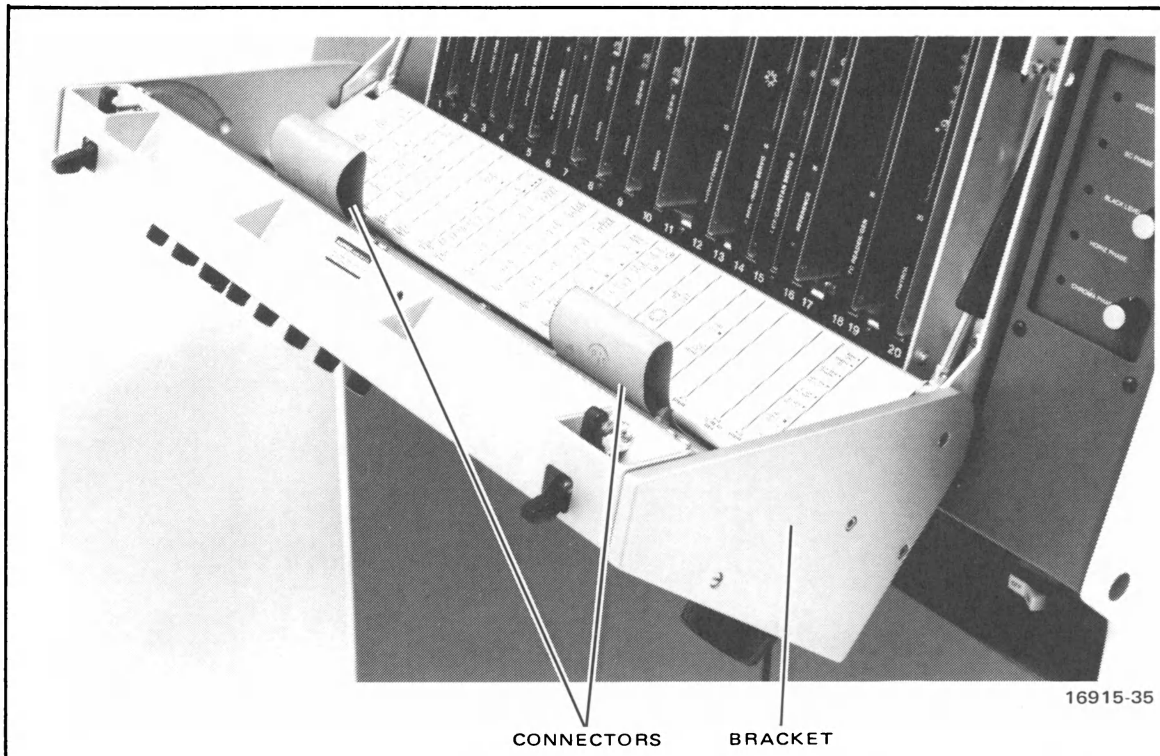


Figure 4-6. Control Panel Bracket Lowered

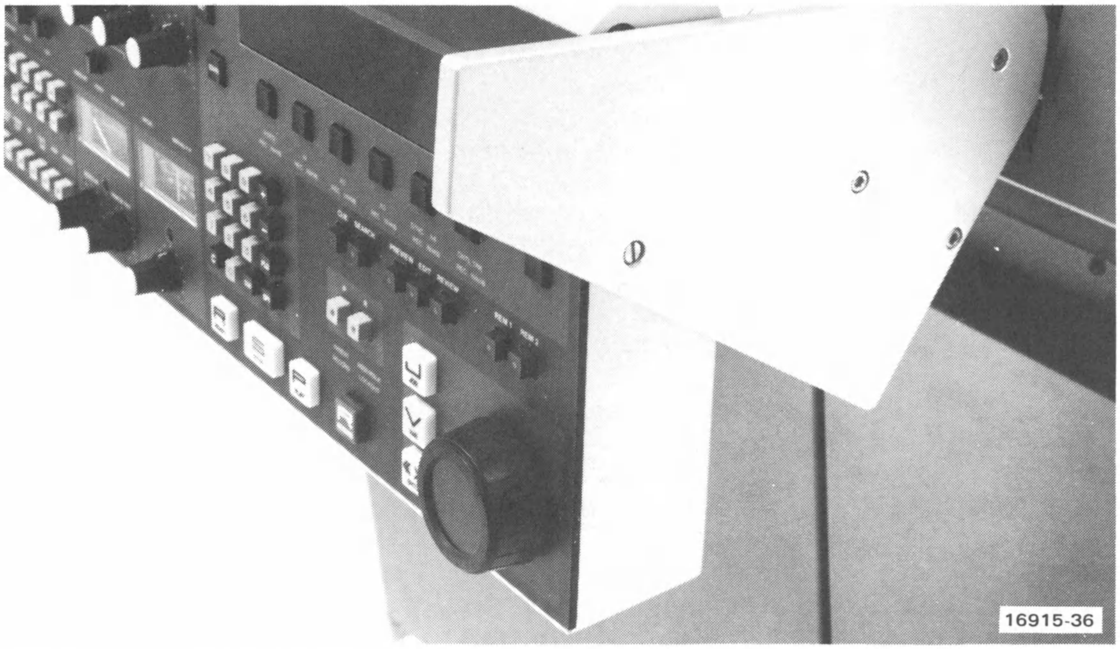


Figure 4-7. Control Panel Suspended Vertically in Lowered Bracket

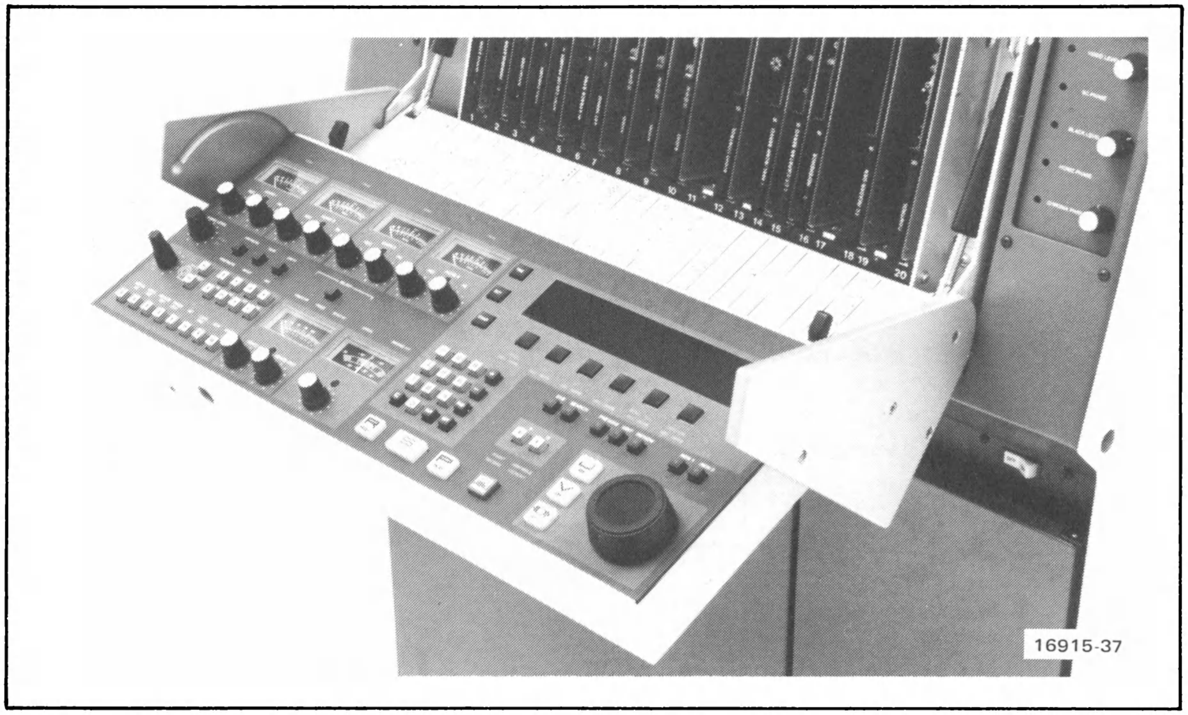


Figure 4-8. Control Panel Facing Upward in Lowered Bracket

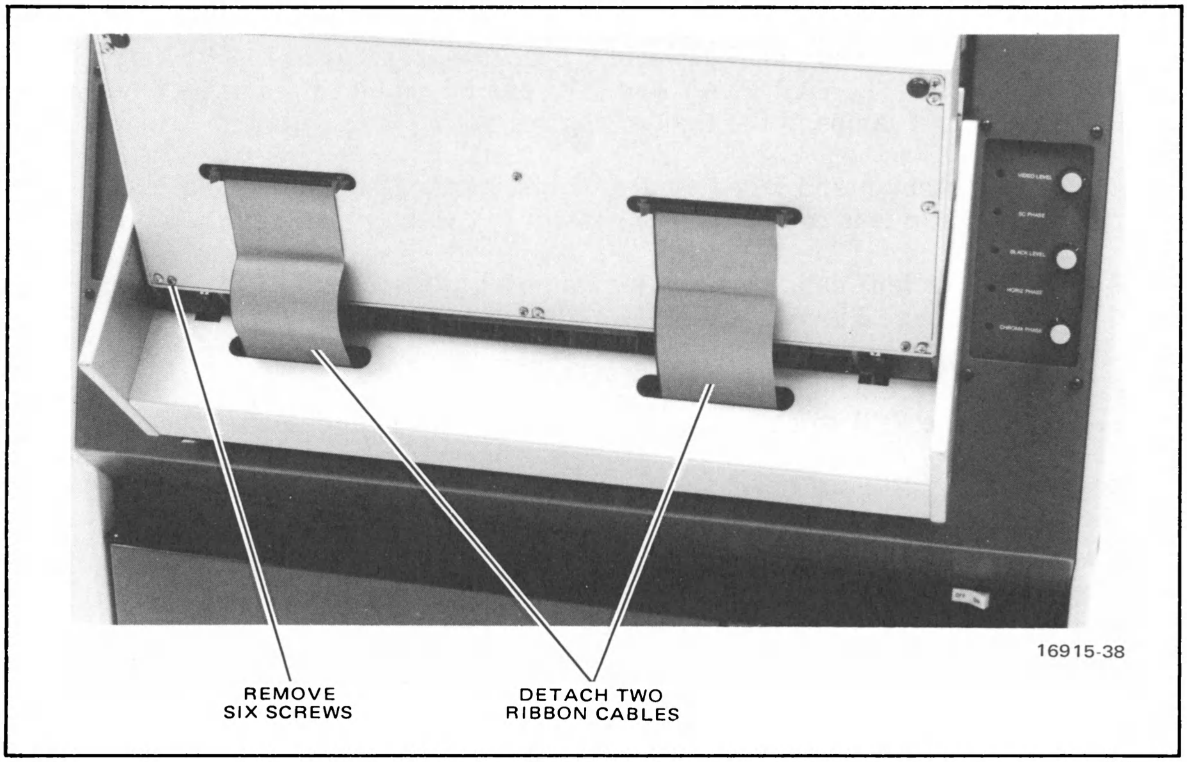


Figure 4-9. Rear Cover of Control Panel Assembly Facing Forward

STEP 9 Turn on VPR-3 power for observation of waveforms at Input/Output PWA test points.

4-57 Meter Lamp Replacement

Meters on the control panel are illuminated by incandescent lamps that are mounted on three Meter Lamp PWAs. There are four lamps mounted on each PWA. These PWAs can be removed and their lamps replaced without removing the control panel assembly from the VPR. Only the back cover of the control panel assembly need be removed to gain access to the Meter Lamp PWAs. Replace meter lamps as follows:

STEP 1 Perform procedures of steps 1—7, paragraph 4-56.

STEP 2 See Figure 4-10. Locate meter lamp PWA having burned out lamp. Remove two screws securing meter lamp PWA to control panel assembly and remove.

STEP 3 Replace lamp with 14V, 8 mA, #73 lamp, Ampex P/N 560-564.

STEP 4 Reinstall Meter Lamp PWA in control panel assembly and secure with two screws.

STEP 5 Replace rear cover of control panel assembly and secure with six screws.

4-58 Control Switch Lamp Replacement

Incandescent lamps are mounted inside the lighted control switches that are on the front panel of the control panel assembly. Burned out lamps in the READY, STOP, PLAY RECORD, SHTL, VAR PLAY and JOG can be replaced from the front panel. Replace burned-out lamps in the lighted control switches as follows:

STEP 1 Using thumb and index finger of one hand, grasp upper and lower edges of plastic lens cap of lighted control switch containing burned-out lamp.

STEP 2 Squeeze lens cap between fingers and while squeezing, lift lens cap from switch. See Figure 4-11.

STEP 3 Use lamp extraction tool provided in the miscellaneous parts kit supplied with the VPR to extract lamp from switch; replace lamp.

STEP 4 Replace lens cap on control switch.

4-59 Control Panel Assembly Removal and Disassembly

The control panel assembly comprises six PWAs and the front panel. The back panel and the chassis frame enclosing the assembly when it is installed on the VPR-3 are parts of the transport trim assembly (see LM 1467380). Replacement of PWAs, audio meters, the fluorescent display, display LEDS, and other components mounted on the PWAs contained in the control panel assembly, require removal of the control panel assembly from the VPR. The back panel must be removed, the

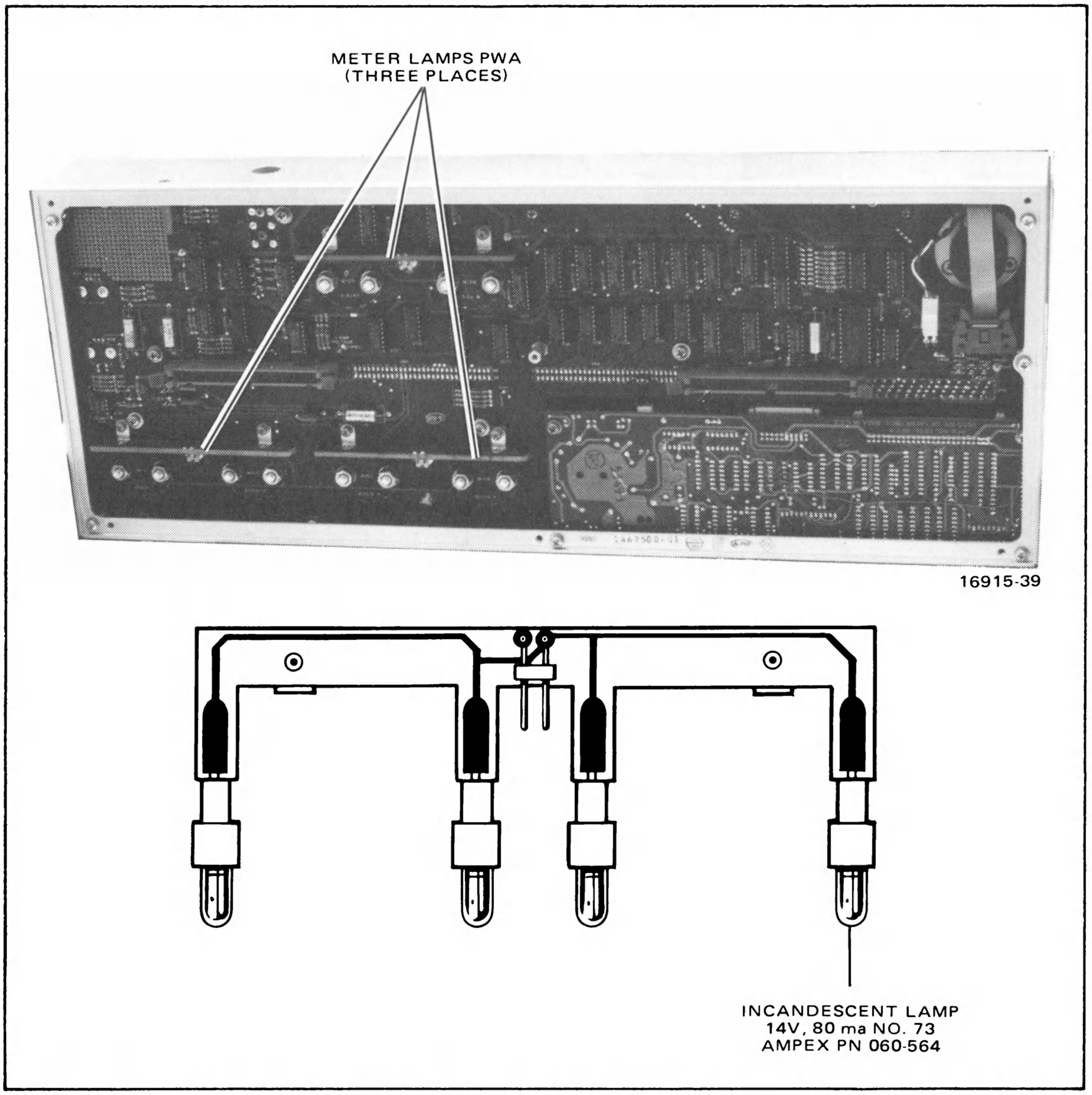


Figure 4-10. Replacing Meter Lamps

assembly must be taken out of the frame that mounts it to the VPR, and it must be disassembled (partially or fully) at a workbench. The level of disassembly required depends upon which PWA needs to be accessed. The PWA containing the part to be replaced should be identified by referring to the parts lists and schematics manual.

Note

It is not necessary to disassemble the control panel assembly to replace the front panel lamps that illuminate the VU meters. These lamps are replaced without removing the control panel assembly from the VPR. Refer to paragraph 4-57.

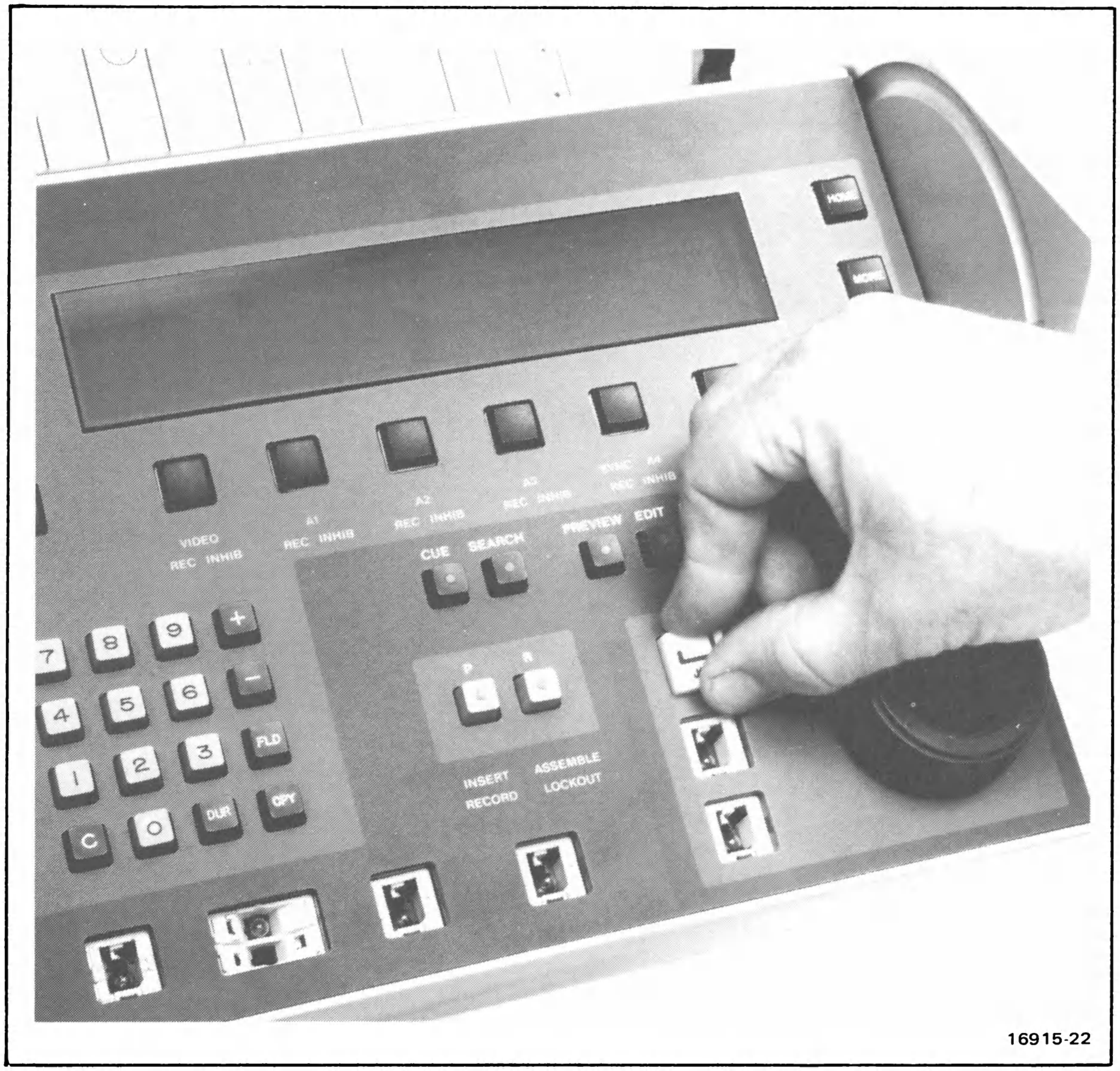


Figure 4-11. Control Switch Lamp Replacement

Procedures for removing the control panel assembly from the VPR-3 and removing all PWAs from the assembly are given in the following paragraphs.

Note that a special tool is required to remove the knobs associated with the audio and video meters on the front panel of the control panel assembly. These knobs must be removed as part of the procedure to remove the Control PWA and the LED PWA from the control panel assembly. The special tool is Ampex Part No. 360-489.

4-60 Control Panel Assembly Removal

Remove control panel assembly from the VPR-3 and gain access to the other control panel PWAs as follows:

STEP 1 Unlatch control panel assembly by pulling two latches forward. Refer to Figure 4-5.

Note

The latches located in top edge of the control panel assembly have two planes of motion. When latches are pulled forward, the control panel is unlatched from the VPR-3 frame. When latches are pressed sideways (toward center of control panel) the control panel assembly is disengaged from detents in the control panel bracket.

STEP 2 Pull top edge of control panel (and control panel bracket) forward. Refer to Figure 4-6.

STEP 3 Press right-hand latch to the left, and at the same time press left-hand latch to the right, allowing control panel to assume a vertical position in the bracket. Refer to Figure 4-7.

STEP 4 Rotate top edge of control panel backward until detent pins engage bracket as shown in Figure 4-8.

STEP 5 Carefully raise the control panel bracket (and panel) as close to stowed position as possible. Refer to Figure 4-9.

STEP 6 With VPR-3 power off, detach two ribbon cable connectors at rear of control panel assembly.

STEP 7 Remove six screws which secure rear cover of control panel assembly and detach cover. Refer to Figure 4-9. Place these six identical screws in a container marked to identify them as control panel cover plate screws.

STEP 8 Remove six screws securing frame to control panel assembly. Note that these six screws are not all the same size. As each screw is removed measure its length and note on the frame adjacent to the hole from which the screw was removed. Of the six screws removed, three are 1 in. long, two are 3/4-in. long, and one is 1/2-in. long.

CAUTION

DURING REINSTALLATION OF ASSEMBLY INTO THE FRAME, IF ATTACHING SCREWS ARE IMPROPERLY LOCATED, CONTROL PANEL ASSEMBLY CAN BE DAMAGED.

STEP 9 Place the six screws in a container marked to identify them as control panel assembly frame-securing screws.

STEP 10 Move control panel down into its lowered position (refer to Figure 4-8).

WARNING

CONTROL PANEL BRACKET IS SPRING LOADED. UNLESS PRECAUTIONS ARE TAKEN TO OVERCOME SPRING TENSION, THE

BRACKET WILL SUDDENLY SNAP BACK TO THE STOWED POSITION WHEN IT IS RELIEVED OF THE CONTROL PANEL WEIGHT, POSSIBLY CAUSING INJURY.

STEP 11 Carefully remove control panel assembly from control panel assembly frame and allow the springs in the bracket struts to return the bracket and frame to the stowed position.

4-61 Control Panel Assembly Disassembly

Disassemble the control panel assembly as follows:

CAUTION

THE CONTROL PANEL ASSEMBLY IS SECURED USING VARIOUS SIZED STANDOFFS, SCREWS, LOCK WASHERS, FLAT WASHERS, ETC. WELL OVER 100 PIECES OF ATTACHING HARDWARE MUST BE REMOVED, IDENTIFIED, STORED, AND REPLACED ACCURATELY. THE CONTROL PANEL ASSEMBLY CAN BE DAMAGED BY INCORRECTLY REPLACING ATTACHING HARDWARE. IT IS RECOMMENDED THAT ATTACHING HARDWARE ASSOCIATED WITH BACK PANEL, FRAME, AND EACH PWA BE PLACED IN INDIVIDUAL CONTAINERS (SUCH AS SMALL PLASTIC BAGS), AND EACH CONTAINER IDENTIFIED BY A TAG CARRYING NAME OF ITEM OR PWA FROM WHICH HARDWARE WAS REMOVED.

4-62 Input/Output PWA Removal

Remove the Input Output PWA from the control panel assembly as follows:

STEP 1 Remove control panel assembly from control panel chassis in accordance with procedure of paragraph 4-60.

STEP 2 Remove knobs from shafts of the A1 & A2 LEVEL controls on front panel; this is a double shaft control.

a. Carefully pry knob's center cover out of knob to expose mounting hardware.

b. Using a pair of long nose pliers, reach down into knob to loosen nut securing knob to shaft.

c. Remove upper and lower knob. Note that there is a wavy washer used between the upper and lower knobs.

d. Remove white plastic collar inserted over shaft. Note that collar is installed so that the flange is up (approximately flush with the surface of the front panel).

STEP 3 Repeat procedure of step 2 to remove knobs from shafts of LR control on front panel.

STEP 4 Place knobs and wavy washers removed in steps 2 and 3 in a container marked to identify contents.

STEP 5 Remove six screws and one hexagonal standoff securing Input/Output PWA to assembly (see Figure 4-12). Note that removed standoff is 1/2 in. long. The hole from which the standoff was removed is centered on a hexagonal shaped pad identified with the letter K. Note that the six screws are 5/8 in. hex head. Lock washers and six identical flat washers are used.

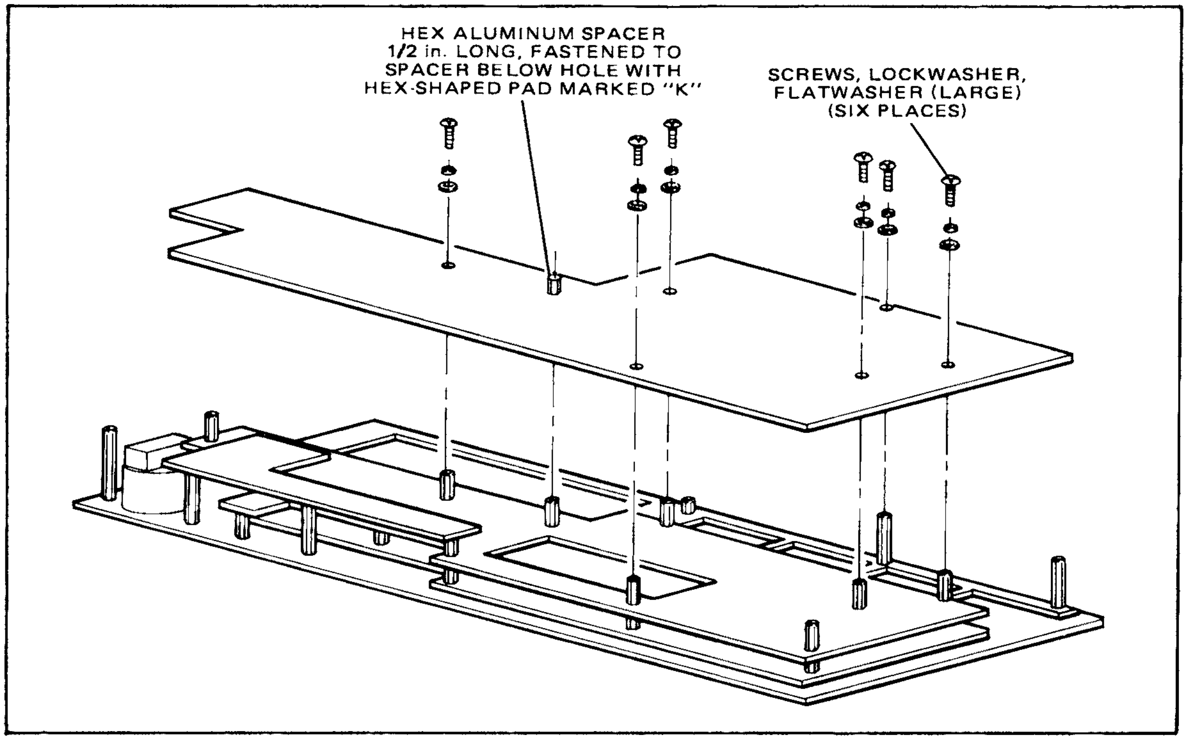


Figure 4-12. Mounting Input /Output PWA to Control Panel Assembly

STEP 6 Place the Input/Output PWA mounting hardware removed in step 5 in a container marked to identify contents.

STEP 7 Disconnect electrical connector that connects Input/Output PWA to Display Logic PWA.

STEP 8 Remove Input/Output PWA from control panel assembly.

4-63 Control Switches PWA Removal

Remove the Control Switches PWA from the control panel assembly as follows:

STEP 1 Remove control panel assembly from control panel chassis in accordance with procedures of paragraph 4-60.

STEP 2 Remove four screws securing Control Switches PWA to assembly. The location of this mounting hardware is indicated in Figure 4-13. Note that four screws are 5/8-in. hex head. Lock washers and four small identical flat washers are used.

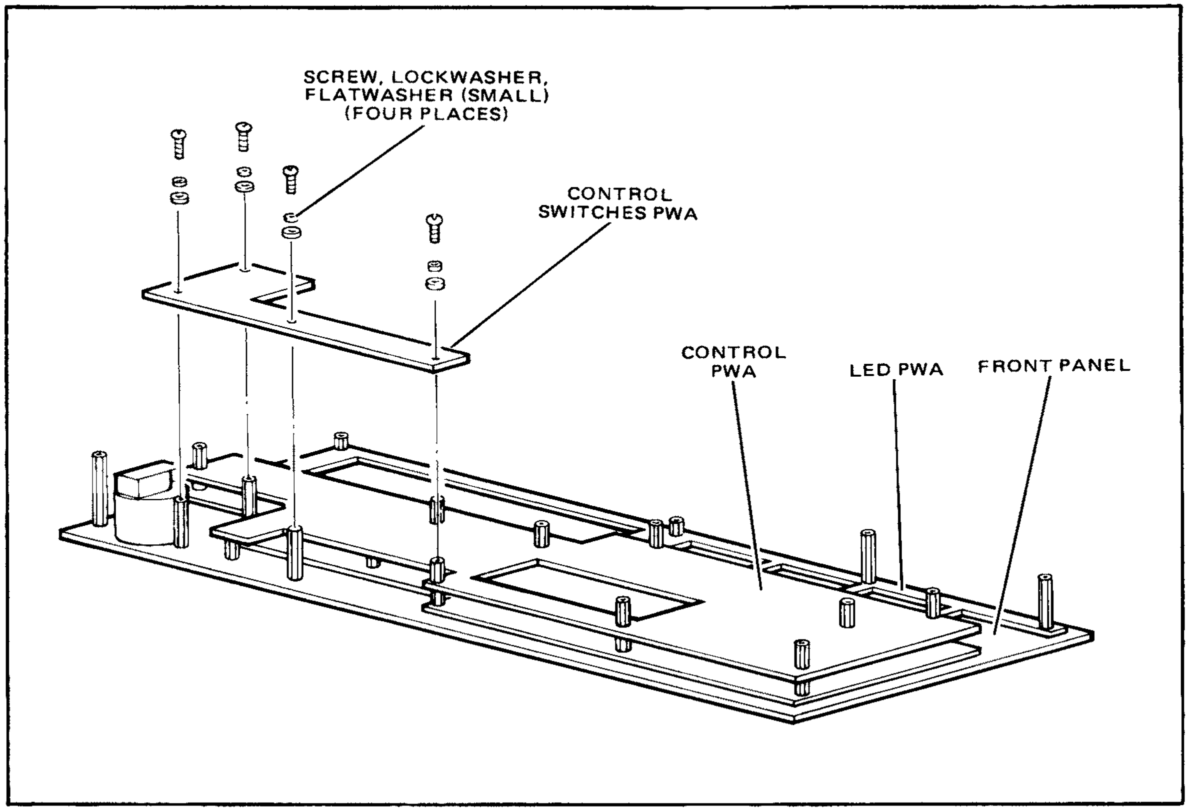


Figure 4-13. Mounting Control Switches PWA on Control Panel Assembly

STEP 3 Place Control Switches PWA mounting hardware removed in step 1 in a container marked to identify contents.

STEP 4 Remove Control Switches PWA from control panel assembly.

4-64 Control PWA Removal

Remove the Control PWA from the control panel assembly as follows:

STEP 1 Remove control panel assembly from the control panel chassis in accordance with procedures of paragraph 4-60.

STEP 2 With the exception of the shuttle control knob on the lower right hand corner of the control panel, remove all control knobs from shafts on the control panel assembly's front panel.

a. Carefully pry center cover out of knobs to expose mounting hardware.

b. Using a special knob removal tool (Ampex P/N 360-489), reach down into knob to loosen the nut that secures knob to shaft (Figure 4-14).

STEP 3 Place knobs and knob center covers removed in step 2 in a small plastic bag or other suitable marked container.

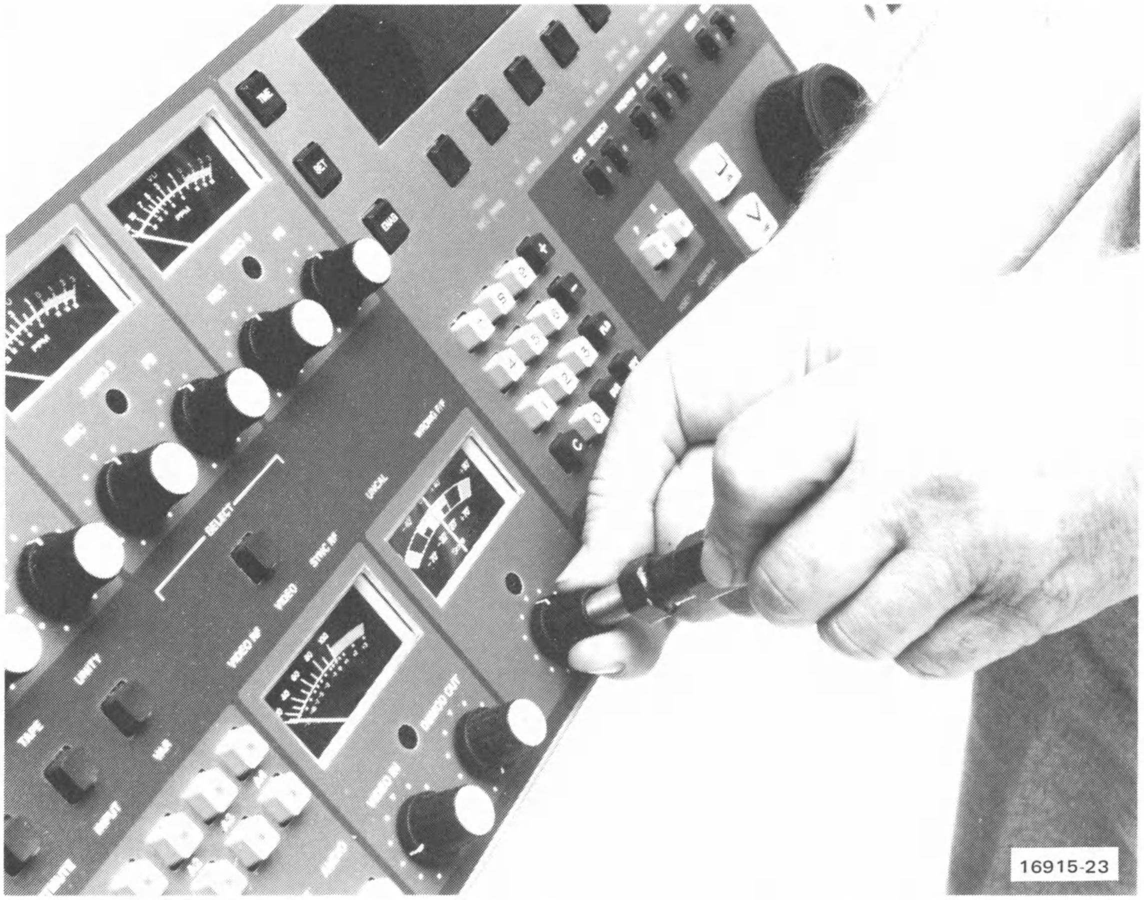


Figure 4-14. Removing Control Panel Knobs

STEP 4 Remove five screws and nine hexagonal standoffs that secure Control PWA to assembly (see Figure 4-15).

a. Remove eight 3/4-in. standoffs from holes centered on hexagonal shaped pads identified by the letter F.

b. Remove one 1/2-inch standoff and small flat washer from a hole centered in a hexagonal shaped pad identified with the letter J. (All standoffs are male at one end and female at the opposite end.)

c. Remove five 5/8 in. screws and five lock washers (four large and one small lock washer) from holes centered on circular pads (see Figure 4-15).

STEP 5 Place the hardware removed in step 5 into a container marked with contents.

STEP 6 Disconnect electrical connector

STEP 7 Remove Control PWA from control panel assembly.

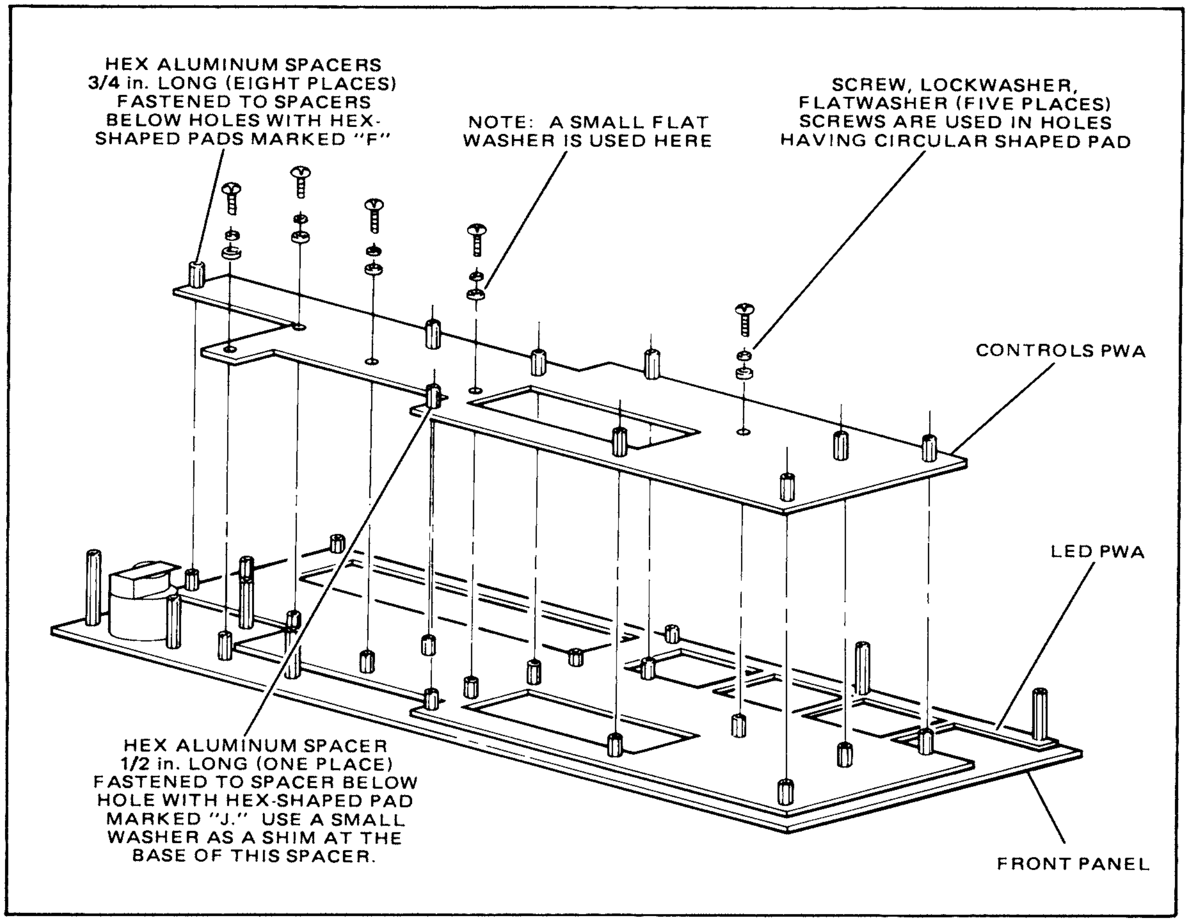

HEX ALUMINUM SPACERS 3/4 in. LONG (EIGHT PLACES) FASTENED TO SPACERS BELOW HOLES WITH HEX-SHAPED PADS MARKED "F"
NOTE: A SMALL FLAT WASHER IS USED HERE
SCREW, LOCKWASHER, FLATWASHER (FIVE PLACES) SCREWS ARE USED IN HOLES HAVING CIRCULAR SHAPED PAD
CONTROLS PWA
LED PWA
HEX ALUMINUM SPACER 1/2 in. LONG (ONE PLACE) FASTENED TO SPACER BELOW HOLE WITH HEX-SHAPED PAD MARKED "J." USE A SMALL WASHER AS A SHIM AT THE BASE OF THIS SPACER.
FRONT PANEL

Figure 4-15. Mounting Controls PWA to LED PWA

4-65 LED PWA Removal

Remove the LED PWA from the control panel assembly as follows:

STEP 1 Remove control panel assembly from control panel chassis in accordance with procedures of paragraph 4-60.

STEP 2 Remove Input/Output PWA in accordance with procedures of paragraph 4-62.

STEP 3 Remove Control PWA in accordance with procedures of paragraph 4-64.

STEP 4 Remove nineteen standoffs securing LED PWA to back of control panel assembly front panel. Location of this mounting hardware is indicated in Figure 4-16.

a. Remove 13 9/16-in. long standoffs from holes centered in hexagonal shaped pads identified by the letter C.

b. Remove four 7/16-in. standoffs from holes centered in hexagonal shaped pads identified with the letter A.

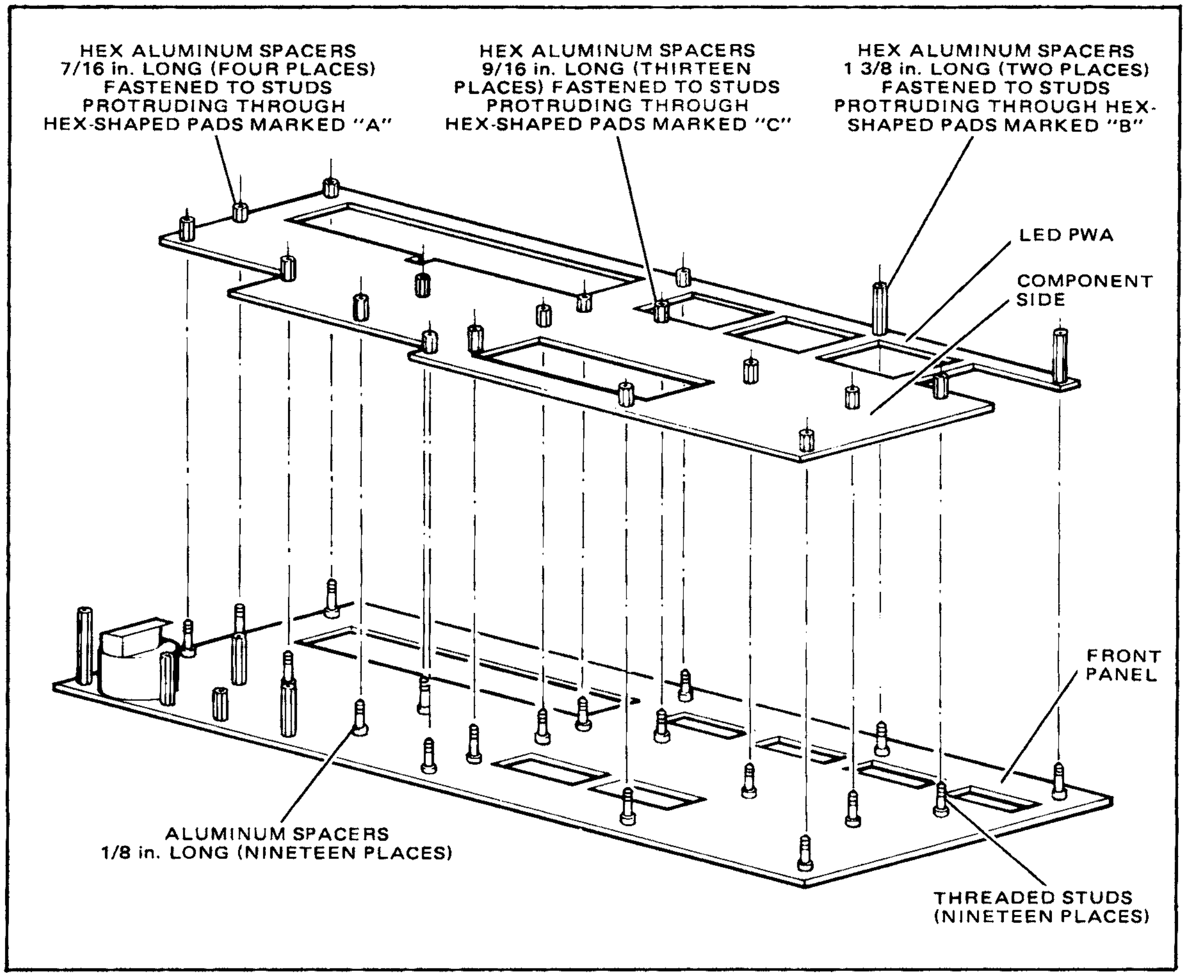

HEX ALUMINUM SPACERS 7/16 in. LONG (FOUR PLACES) FASTENED TO STUDS PROTRUDING THROUGH HEX-SHAPED PADS MARKED "A"
HEX ALUMINUM SPACERS 9/16 in. LONG (THIRTEEN PLACES) FASTENED TO STUDS PROTRUDING THROUGH HEX-SHAPED PADS MARKED "C"
HEX ALUMINUM SPACERS 1 3/8 in. LONG (TWO PLACES) FASTENED TO STUDS PROTRUDING THROUGH HEX-SHAPED PADS MARKED "B"
LED PWA
COMPONENT SIDE
FRONT PANEL
ALUMINUM SPACERS 1/8 in. LONG (NINETEEN PLACES)
THREADED STUDS (NINETEEN PLACES)

Figure 4-16. Mounting LED PWA to Front Panel

c. Remove two 1-3/8-in. standoffs from holes centered in hexagonal shaped pads identified with the letter B.

STEP 5 Place LED PWA mounting hardware removed in step 4 into a container marked with contents.

STEP 6 Remove LED PWA from front panel of control panel assembly.

STEP 7 Remove the four small unthreaded standoffs on which the LED PWA was seated. Store them in a marked container.

4-66 26 x 256 Display Logic PWA Removal

Remove the 26 x 256 Display Logic PWA from the control panel assembly as follows:

STEP 1 Remove control panel assembly from control panel chassis in accordance with procedure of paragraph 4-60.

STEP 2 Remove two 5/8 in. hex-head screws and washers securing the 26 x 256 Display Logic PWA to control panel assembly (see Figure 4-17).

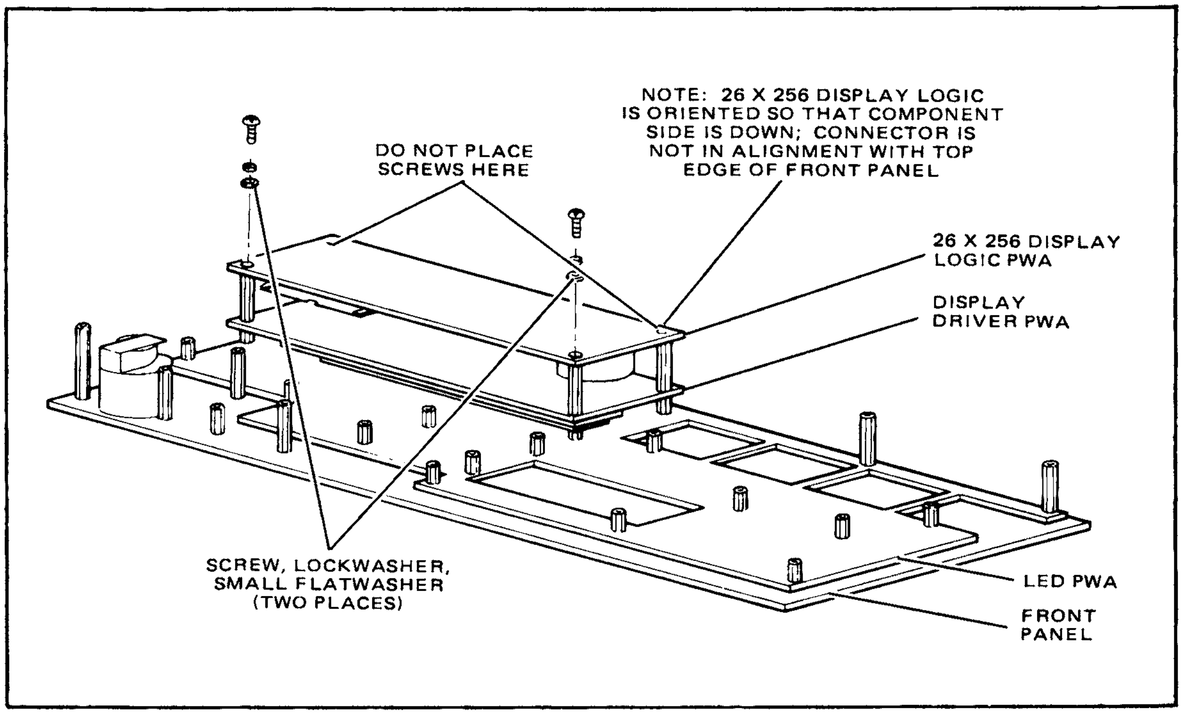

NOTE: 26 X 256 DISPLAY LOGIC IS ORIENTED SO THAT COMPONENT SIDE IS DOWN; CONNECTOR IS NOT IN ALIGNMENT WITH TOP EDGE OF FRONT PANEL
DO NOT PLACE SCREWS HERE
26 X 256 DISPLAY LOGIC PWA
DISPLAY DRIVER PWA
SCREW, LOCKWASHER, SMALL FLATWASHER (TWO PLACES)
LED PWA
FRONT PANEL

Figure 4-17. Mounting 26 x 256 Display Logic PWA to Display Driver PWA

STEP 3 Place mounting hardware removed in step 2 into a marked container.

STEP 4 Disconnect electrical connections from Input/Output PWA and Display Driver PWA.

STEP 5 Remove 26 x 256 Display Logic PWA from control panel assembly.

4-67 Display Driver PWA Removal

Remove the Display Driver PWA from the control panel assembly as follows:

STEP 1 Remove control panel assembly from control panel chassis in accordance with procedures of paragraph 4-60.

STEP 2 Remove 26 x 256 Display Logic PWA from control panel assembly in accordance with procedure of paragraph 4-66.

STEP 3 Remove the four 1-1/8 inch long standoffs that secure the Display Driver PWA to the control panel assembly. Note that the standoffs removed are male on one end and female at the other end. Refer to Figure 4-18.

STEP 4 Place the Display Driver PWA mounting hardware removed in step 3 into a marked container.

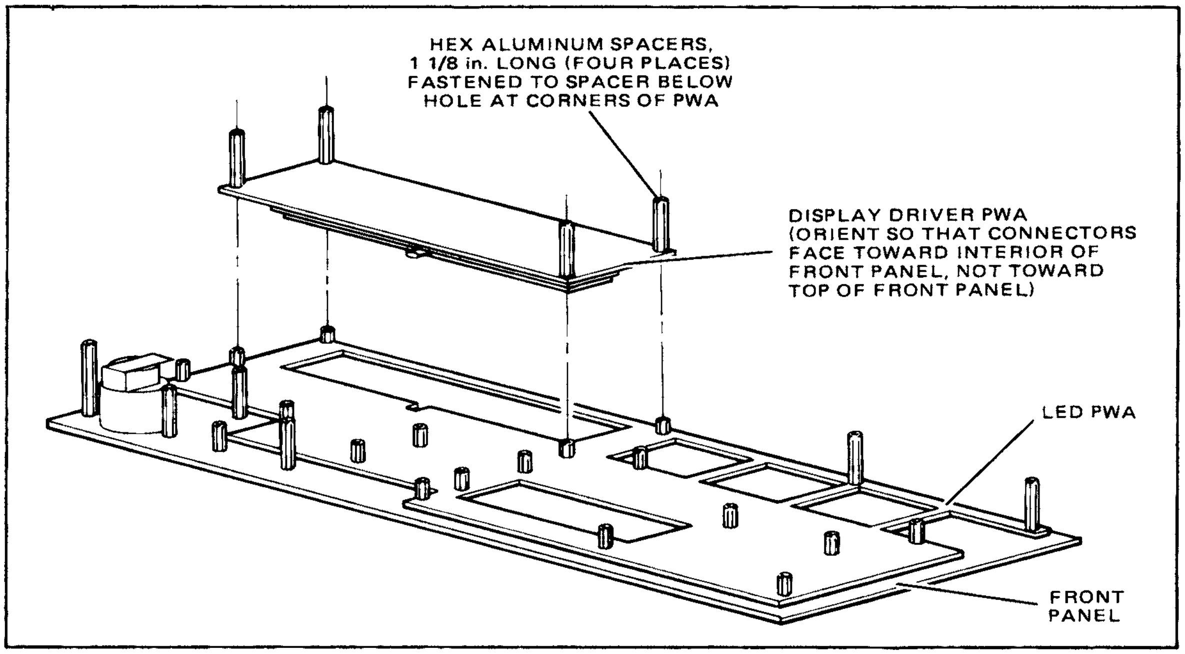

HEX ALUMINUM SPACERS, 1 1/8 in. LONG (FOUR PLACES) FASTENED TO SPACER BELOW HOLE AT CORNERS OF PWA
DISPLAY DRIVER PWA (ORIENT SO THAT CONNECTORS FACE TOWARD INTERIOR OF FRONT PANEL, NOT TOWARD TOP OF FRONT PANEL)
LED PWA
FRONT PANEL

Figure 4-18. Mounting Display Driver PWA to Front Panel

STEP 5 Remove the Display Driver PWA from the control panel assembly.

STEP 6 Remove the four small unthreaded standoffs on which the Display Driver PWA was seated. Store these standoffs in a marked container.

4-68 Control Panel Assembly Reassembly and Replacement

The control panel assembly can be reassembled and replaced into the VPR by reversing the procedures used to remove and disassemble it. Care must be taken to replace the PWAs in same position in the assembly from which they were removed. Replacement of the PWAs and the assembly using the securing hardware incorrectly could result in damage to the unit. Figures 4-12 through 4-18 are provided for use as a guide in reassembling the Control Panel Assembly.

4-69 TROUBLESHOOTING

The most straightforward approach to troubleshooting symptoms of malfunction is through use of the diagnostic program which is included in the later VPR-3s (software version 4/5 and subsequent). Fault isolation in earlier VPR-3s, not so equipped, depends on less convenient, more traditional methods of analysis.

The VPR-3 diagnostic program includes routines specifically dedicated to troubleshooting components within the control and reference system. These are the Control PWA, Reference Generator PWA, and control panel diagnostic routines. These automated routines are provided in addition to the interactive routines which employ the accessory diagnostic probe. Refer to the *VPR-3 Diagnostics Maintenance Manual* (Ampex Catalog No. 1809650) for instructions on diagnostic program use.

4-70 Control PWA

Certain assumptions must be made in order to establish a starting point for troubleshooting. The major assumption is that symptoms of malfunction are caused by hardware faults. Although software faults are neither impossible nor unheard of, assuming a software fault almost always leads nowhere and can be discounted by thorough troubleshooting. Even if a fusible-link junction within a PROM should heal, causing program violation, the root cause is hardware fault.

The following subparagraphs offer some common sense suggestions that are easy to implement. For example, start with a measurement of the +5 and +12 Vdc bus lines. Look at the Vcc input of the CPUs, 20U39-11 and 20U45-11. If Vcc goes below +4.7 Vdc without causing power-down reset, the Control PWA will go crazy.

4-71 CPU Subsystems

Look at the clock output of oscillator 20U26. Check not only the 4-MHz clock frequency, but also be sure that the amplitude is greater than +4.7 Vdc. This is often the cause of trouble.

Check interrupt inputs to the CPUs. The nonmaskable interrupt (NMI) to the main CPU is seen at 20TP22. This input should be negative-going 60- (or 50-) Hz field rate pulses when the VPR-3 is in play mode. (There is no NMI to the remote CPU.) Look at INT request inputs to the main CPU at 20TP12 and to the remote CPU at 20U45-16. These inputs should also be negative-going field rate pulses. Interrupts come from the tape timer also, and INT pulse rate should increase in direct proportion to tape speed. Observing this checks out whether CTC no. 2 (20U62) and PIO 20U42 are working properly.

Do not overlook green LED indicators 2DS1 (MAIN CPU RUN) and 20DS2 (REM CPU RUN). These indicators are switched on and off at frame rate. If they are continuously lighted or unlighted, no regular interrupt is being received by the CPUs. It is also possible that they are being interrupted too often, not often enough, or not at all. Look at 20TP10. The WAIT inputs to the main CPU at 20TP10 should be pulses at interrupt rate. There is no WAIT input to the remote CPU.

4-72 Bus Structure

The primary tool in checking out the main CPU, remote CPU, and system address bus structures is the NOP jumper. This is jumper 20J10 for the main CPU and 20J8 for the remote CPU. These jumpers check out the address buses and the decoders. When the NOP jumper is moved to the NOP position, all data bus lines are grounded and a NOP instruction is forced on the CPU. NOP causes the CPU to step through its address count outputs sequentially. Therefore, the A0—A15 address bus lines appear as a 16-bit binary counter.

Check bidirectional data buffer 20U63 for data communication with other PWAs. If the Control PWA is removed with power on, 20U63 may be damaged. Look at the output of address decoders 20U69, U56, and U2. The outputs of 20U69 should appear as a three-phase set of pulses: first zeros for a block of address, then CS1, then CS2.

Look at the data, address, and service buses with the NOP jumper in the NORMAL position. You should see plenty of high/low transitions, and, although there is no way to know the timing, as long as there is activity on the lines, they are all right. If the lines are permanently high or low, they are being pulled up or down by something such as a solder splash. The best aid to determine the point at which the line is pulled up or down is a current tracer (determines point of maximum current).

4-73 Serial Interface

If the amber TX REM and RX REM LED indicators are off or only dimly lighted when serial data exchange is attempted, there is either a communication disconnect or a cable impedance problem. If serial data communication cable is used which has other than RS-422A-specified impedance (91Ω), there will be an impedance mismatch and resulting reflections. For example, if microphone or twin-twisted audio cable, having an impedance of about 150Ω, must be used, there will be an impedance matching problem. In that case, remove the jumpers across the line receiver inputs (20J1, J2, J5, and J6). This leaves only the impedance of the line receiver which is about 180Ω.

4-74 JUMPERS

The following tables list the functions of jumpers on the Control, Reference Generator, Color Framer Detector, and Playback Sync PWAs. The five control panel PWAs and the Tape Remaining PWA are not equipped with jumpers.

4-75 Control PWA (1467200 and 1467203)

In addition to jumpers for testing purposes, the Control PWA is equipped with jumpers for matching serial transmission line impedance. The jumpers are listed and shown in Table 4-10. The illustration of Table 4-10 shows 20BT1 and the associated battery charger circuit. These components are not included on Control PWA 1467203.

4-76 Reference Generator PWA (1467220 and 1467217)

Jumpers on the following Reference Generator PWAs are listed and shown in Table 4-11. These are the Reference Generator PWAs of earlier design which are accompanied by the Tape Remaining PWA.

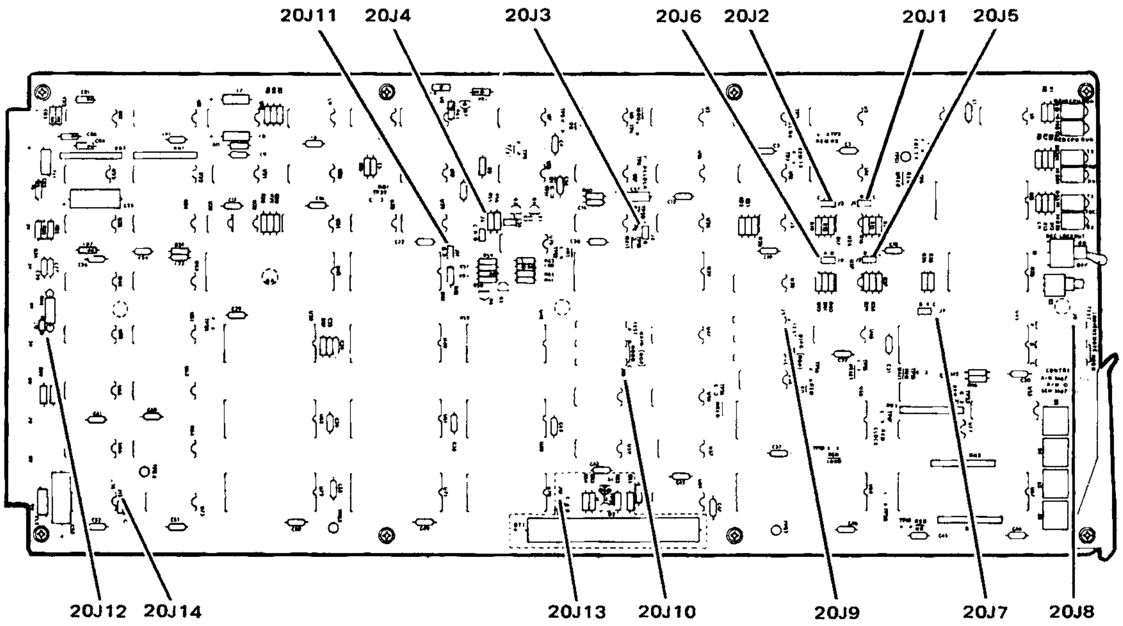
- Reference Generator PWA 1467220, 525-line video
- Reference Generator PWA 1467217, 625-line video

4-77 Reference Generator PWA (1467160 and 1467163)

Jumpers on the following Reference Generator PWAs are listed and shown in Table 4-12. These are the Reference Generator PWAs of later design.

- Reference Generator PWA 1467160, 525-line video
- Reference Generator PWA 1467163, 625-line video

Table 4-10. Control PWA Jumpers



Jumper	Position	Function
20J1	A-B	Normal. Connects 180Ω resistor 20R16 across inputs of line receiver 20U24-2, providing 91Ω terminal impedance.
	B-C	Disconnects resistor 20R16. Refer to paragraph 4-62.
20J2	A-B	Normal. Connects 180Ω resistor 20R17 across inputs of line receiver 20U24-3, providing 91Ω terminal impedance.
	B-C	Disconnects resistor 20R17. Refer to paragraph 4-62.
20J3	A-B	Normal. Connects extended wait generator circuitry to low-active WAIT input of main CPU 20U39.
	Removed	Disconnects WAIT input. Main CPU will not enter wait condition following each instruction output.
20J4	A-B	Normal. Allows V/2 to strobe input ports A and B of PIO 20U67 for VTR ID number. Refer to paragraph 4-26.
	A-C	Test position. Disables port A and B frame rate strobe pulses.
20J5	A-B	Normal. Connects 180Ω resistor 20R39 across inputs of line receiver 20U37-2, thus providing 91Ω terminal impedance.
	B-C	Disconnects resistor 20R39. Refer to paragraph 4-62.

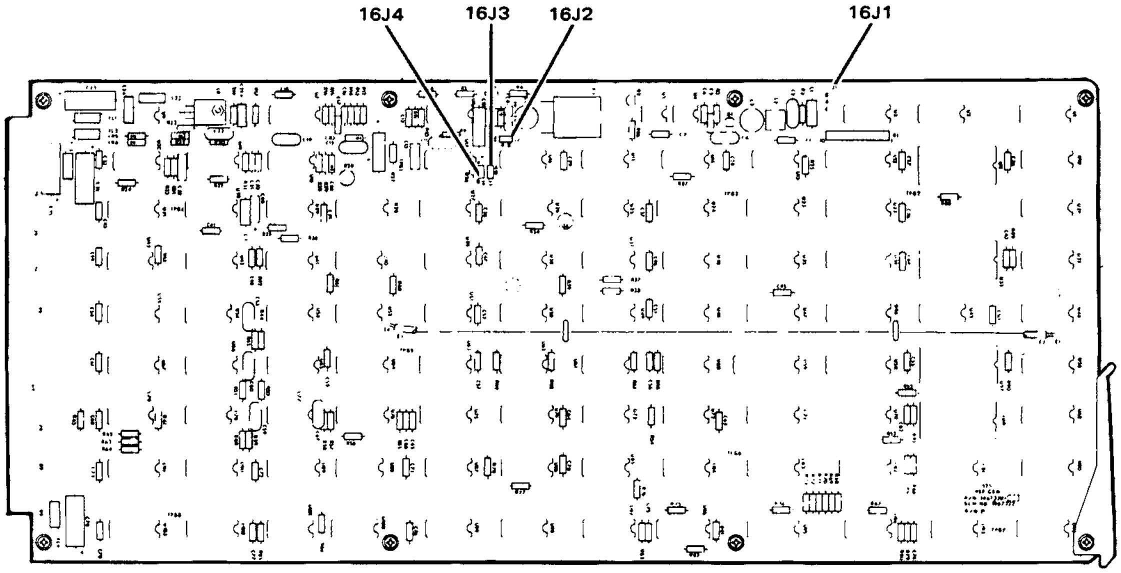
(Continued next page)

Table 4-10. Control PWA Jumpers (Continued)

Jumper	Position	Function
20J6	A-B	Normal. Connects 180Ω resistor 20R40 across inputs of line receiver 20U37-3, thus providing 91Ω terminal impedance.
	B-C	Disconnects resistor 20R40. Refer to paragraph 4-62.
20J7	A-B	Normal. Connects low-active INT input to remote CPU 20U45.
	B-C	Disconnects INT input to remote CPU.
20J8	A-B	Pulls all bits on remote CPU data bus low, artificially inserting a NOP instruction. Refer to paragraph 4-61.
	B-C	Normal position. Connects remote CPU data bus to remote CPU 20U45.
20J9	A-B	Factory test only. Routes outputs of three serial line drivers back into the three corresponding line receivers.
	B-C	Normal position. Completes connection of balanced line outputs of three serial line drivers.
20J10	A-B	Pulls all bits on main CPU data bus low, artificially inserting a NOP instruction. Refer to paragraph 4-61.
	B-C	Normal position. Connects main CPU data bus to main CPU 20U39.
20J11	A-B	Normal. Connects low-active interrupt input (INT) to main CPU 20U39.
	B-C	Disconnects INT input to main CPU.
20J12	A-B	Normal. Connects power trip output of data latch 20U43 to power supply.
	Removed	Power trip output disconnected.
20J13*	A-B	Normal. Connects battery 20BT1 to main CPU RAMs 20U48, U60, and U70.
	B-C	Grounds Vcc inputs of main CPU RAMs.
20J14	A-B	Normal. No function.
	B-C	Test position. Forces air switch input indication (low) on system data bus.

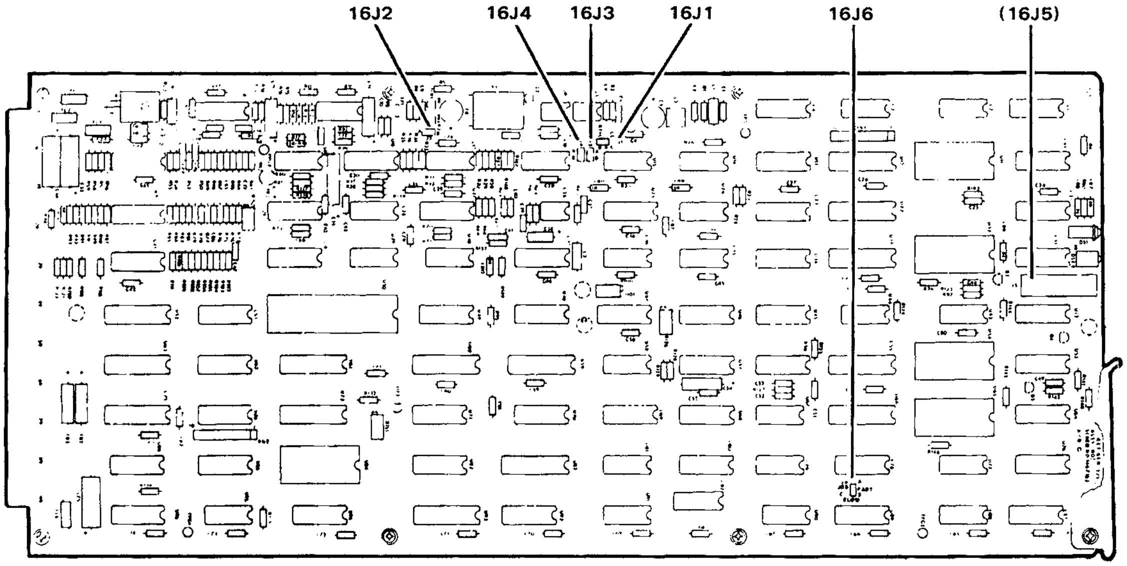
*Functional only on earlier VPR-3s (Control PWA No. 1467200).

Table 4-11. Reference Generator PWA (1467220 and 1467217) Jumpers



Jumper	Position	Function
16J1	A-B	Connects crystal oscillator 16Y1/C8, locked to selected reference sync, as source of 128H master clock.
	A-C	Connects L-C oscillator 16L2/C3 as source of 128H master clock
16J2	A-B Removed	Normal. Connects error control voltage to 128H oscillators. Disconnects error control voltage from 128H oscillators.
16J3	A-B Removed	Normal. Connects 128H output of crystal oscillator 16Y1/C8. Disconnects 128H output of crystal oscillator 16Y1/C8.
16J4	A-B Removed	Normal. Connects 128H output of L-C oscillator 16L2/C3. Disconnects 128H output of L-C oscillator 16L2/C3.

Table 4-12. Reference Generator PWA (1467160 and 1467163) Jumpers



Jumper	Position	Function
16J1	A-B A-C	Connects crystal oscillator 16Y1/C8, locked to selected reference sync, as source of 128H master clock. Connects L-C oscillaotr 16L2/C3 as source of 128H master clock.
16J2	A-B Removed	Normal. Connects error control voltage to 128H oscillators. Disconnects error control voltage from 128H oscillators.
16J3	A-B Removed	Normal. Connects 128H output of L-C oscillator 16L2/C3. Disconnects 128H output of L-C oscillator 16L2/C3.
16J4	A-B Removed	Normal. Connects 128H output of crystal oscillator 16Y1/C8. Disconnects 128H output of crystal oscillator 16Y1/C8.
(16J5)		(Diagnostic probe connector)
16J6	A-B B-C	Fast jog. Connects 2X knob tach to knob tach counter clock input for jog speed control. Slow jog. Connects phase B knob tach to knob tach counter clock input for jog speed control.

4-78 Color Frame Detector PWA, NTSC (1467050)

Jumpers on the NTSC Color Frame Detector PWA are listed and located in Table 4-13.

4-79 Color Frame Detector PWA, PAL (1467053)

Jumpers on the PAL Color Frame Detector PWA are listed and located in Table 4-14.

4-80 Color Frame Detector PWA, SECAM (1467750)

Jumpers on the SECAM Color Frame Detector PWA are listed and shown in Table 4-15.

4-81 Playback Sync PWA

Jumpers on the Playback Sync PWA are listed and shown in Table 4-16.

4-82 TEST POINTS

All PWAs in the control and reference system include test points for voltage measurement and observation of waveforms with exception the Controls, LED, Control Switches, and Meter Lamps PWAs, which are part of the control panel assembly.

4-83 Control PWA (1467200 and 1467203)

Test points on the Control PWA are listed and shown in Table 4-17.

4-84 Control Panel PWAs

Of the five PWAs in the control panel assembly, only the Input/Output PWA is equipped with test points.

4-85 Input/Output PWA

Test points on the Input/Output PWA (part of control panel assembly) are listed and shown in Table 4-18.

4-86 Reference Generator PWA (1467220 and 1467217)

The test point on the Reference Generator PWA is listed and shown in Table 4-19.

4-87 Tape Remaining PWA

The test point on the Tape Remaining PWA is listed and shown in Table 4-20.

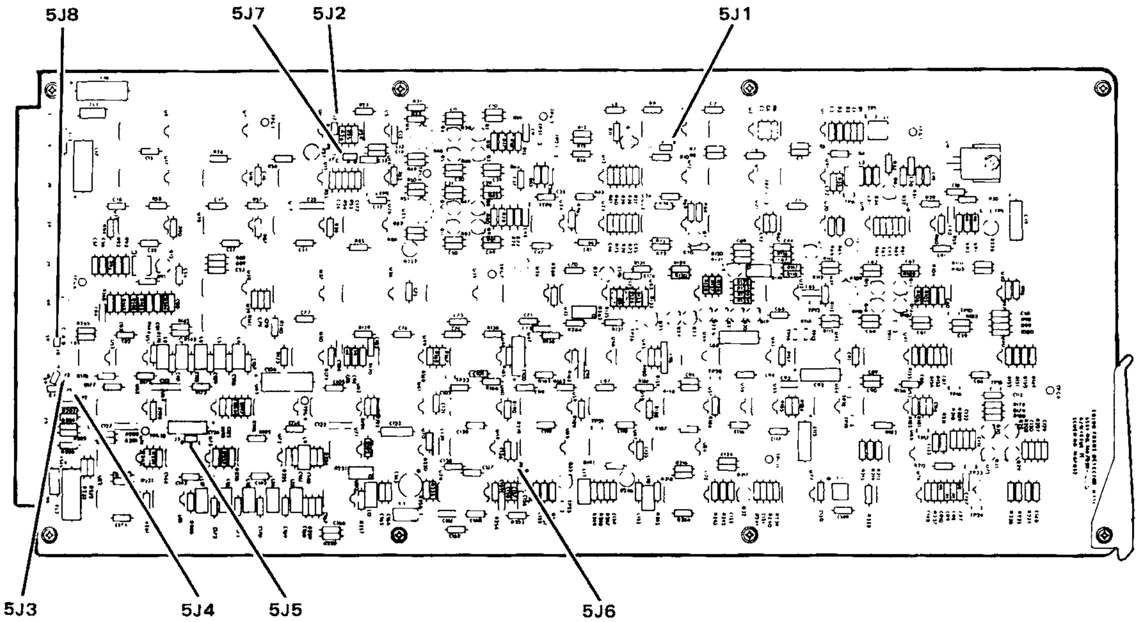
4-88 Reference Generator PWA (1467160 and 1467163)

Test points on the Reference Generator PWA are listed and shown in Table 4-21.

4-89 Color Frame Detector PWA, NTSC

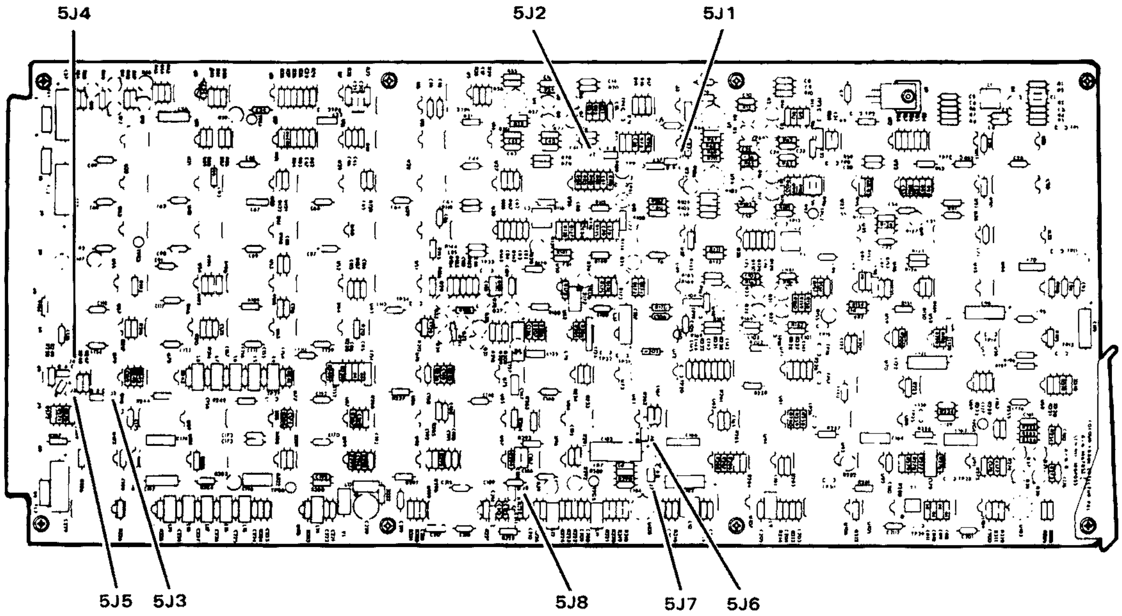
Test points on the NTSC Color Frame Detector PWA are listed and shown in Table 4-22.

Table 4-13. NTSC Color Frame Detector PWA Jumpers



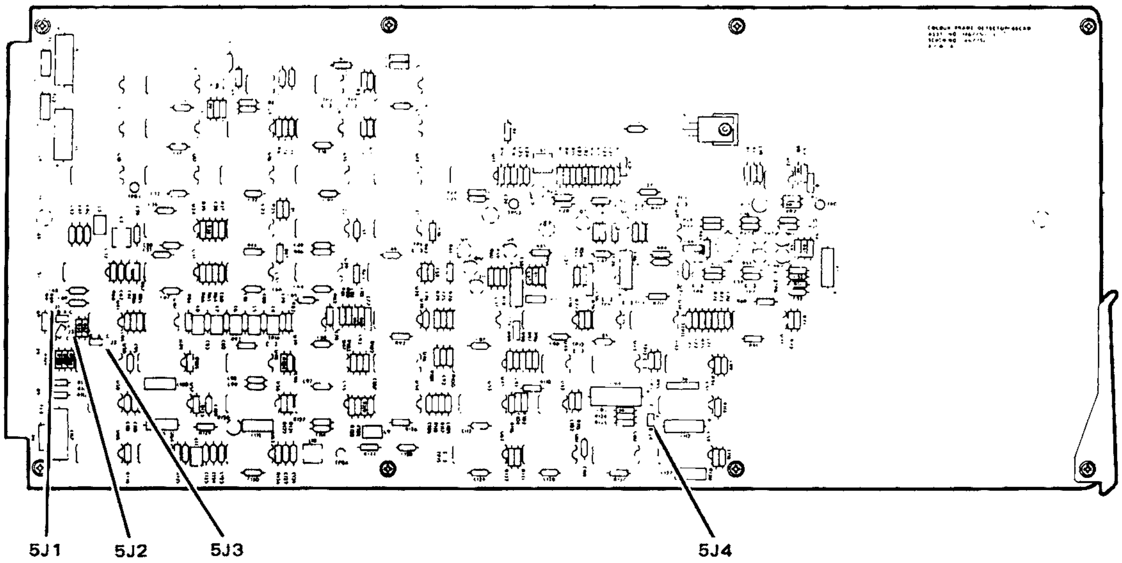
Jumper	Position	Function
5J1	A-B A-C	Normal. Test. Inverts phase of 2X Fsc into comparator.
5J2	A-B A-C	Normal. Test. Inverts polarity of 7.8 kHz 2H into field identifier.
5J3	A-B A-C B-C	Normal. Connects reference to tape video path via 5J4 in A-C position. Connects demod video to reference video color frame detector via 5J8 in A-C position.
5J4	A-B A-C	Normal. Passes reference video through tape video ScH detector via 5J3 in A-C position.
5J5	A-B A-C	Normal. Reference field I identification ignored after initial lock-up.
5J6	A-B A-C	Normal. No function. Used during adjustment of 5C163 (3.58-MHz crystal oscillator).
5J7	A-B A-C	Normal. Test. Changes ScH meter to fast time constant.
5J8	A-B A-C	Normal position. No function. Connects demod video to reference video color frame detector via 5J3 in B-C position.

Table 4-14. PAL Color Frame Detector PWA Jumpers



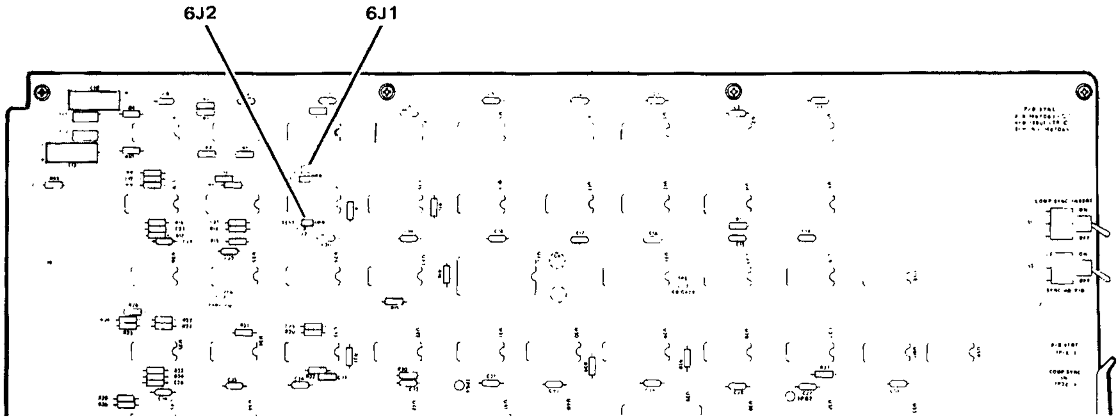
Jumper	Position	Function
5J1	A-B A-C	Normal position Test position. Changes ScH meter to fast time constant.
5J2	A-B A-C	Normal position. Test position. Inverts polarity of 7.8 kHz 2H into field identifier.
5J3	A-B A-C	Normal position. Passes reference video through tape video ScH detector via 5J5 in A-C position.
5J4	A-B A-C	Normal position. No function. Connects demod video to reference video color frame detector via 5J5 in B-C position.
5J5	A-B A-C B-C	Normal position. Connects reference to tape video path via 5J3 in A-C position Connects demod video to reference video color frame detector via 5J4 in A-C position.
5J6	A-B A-C	Normal position. Test position. Inverts phase of 2XFsc into comparator.
5J7	A-B A-C	Normal position. Reference field I identification ignored after initial lockup.
5J8	A-B A-C	Normal position. No function. Used during adjustment of 5C220 (4.43 MHz crystal oscillator).

Table 4-15. SECAM Color Frame Detector PWA Jumpers



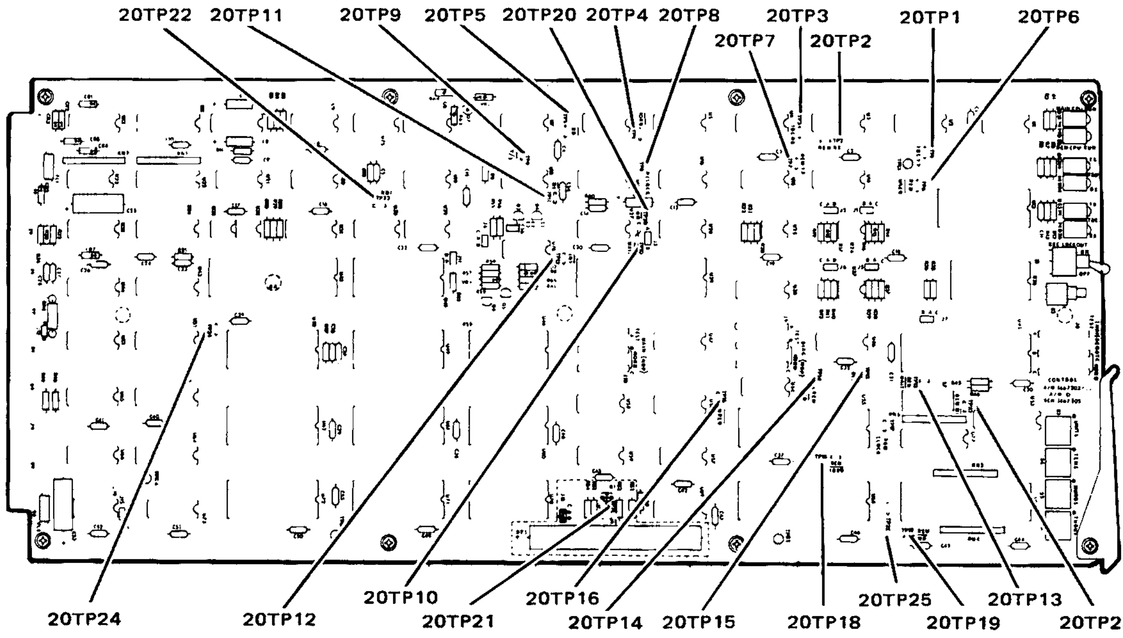
Jumper	Position	Function
5J1	A-B A-C	Normal position. No function. Connects demod video to reference video color frame detector via 5J2 in B-C position.
5J2	A-B A-C B-C	Normal. Connects reference to tape video path via 5J3 in A-C position. Connects demod video to reference video color frame detector via 5J1 in A-C position.
5J3	A-B A-C	Normal. Passes reference video through tape video ScH detector via 5J5 in A-C position.
5J4	A-B A-C	Normal. Reference field I identification ignored after initial lockup.

Table 4-16. Playback Sync PWA Jumpers



Jumper	Position	Function
6J1	A-B A-C	Normal position. Factory test (only) of field counters 6U15, 6U16, and 6U7.
6J2	A-B A-C	Normal. Factory test only of field counters 6U15, 6U16, and 6U7.

Table 4-17. Control PWA Test Points



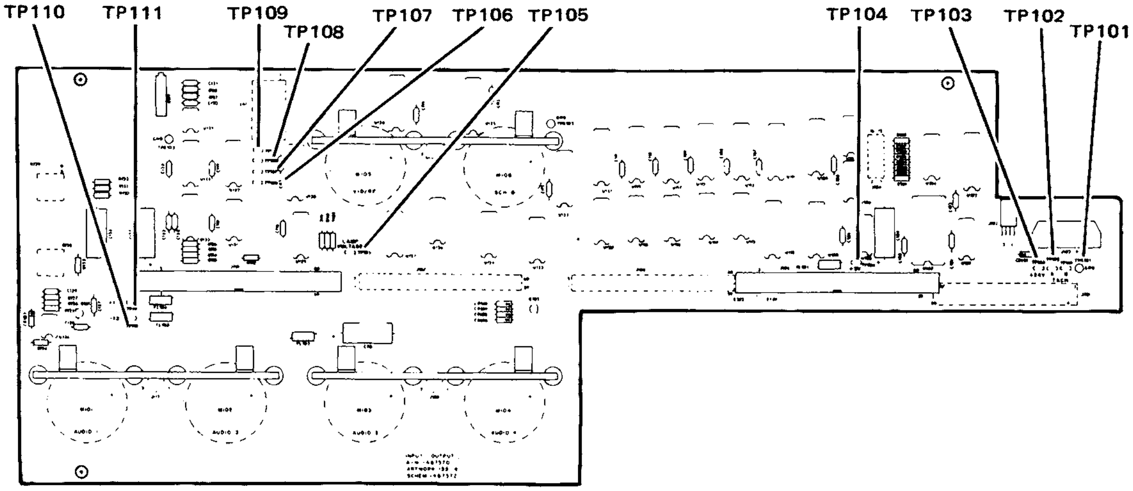
(Continued next page)

Table 4-17. Control PWA Test Points (Continued)

Test Point	Function
20TP1	TBC Tx serial data (TxDB)
20TP2	Remote Rx serial data (RxDA)
20TP3	TBC Rx serial data (Rx DB)
20TP4	IORQ output of main CPU 20U39
20TP5	RD output of main CPU
20TP6	MREQ output of remote CPU 20U45
20TP7	Remote Tx serial data (TxDA)
20TP8	4-MHz clock (phi) to main and remote CPUs
20TP9	V/2 from Reference Generator PWA
20TP10	WAIT input to main CPU
20TP11	M1 output of main CPU
20TP12	INT input to main CPU
20TP13	WAIT input to remote CPU
20TP14	RD output of remote CPU
20TP15	RES input to main CPU
20TP16	MREQ output of main CPU
20TP17	2.4576-MHz clock to DART 20U55
20TP18	IORQ output of remote CPU
20TP19	WR output of remote CPU
20TP20	WR output of maain CPU
20TP21*	Battery voltage
20TP22	NMI input to main CPU
20TP23	M1 output of remote CPU
20TP24	IEO output of main PIO 20U42
20TP25	IEO output of remote PIO 20U67

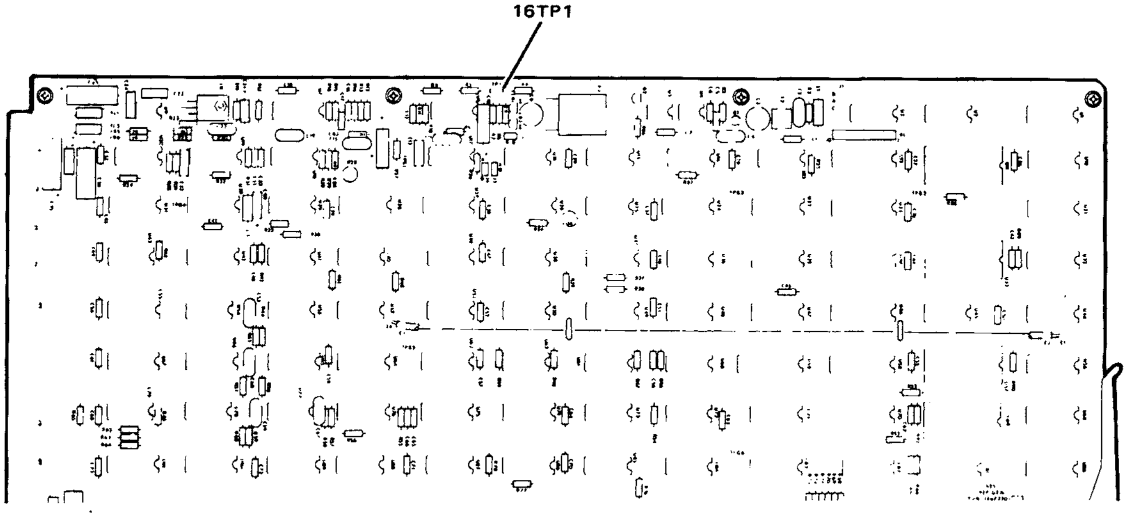
* Control PWA 1467200 only

Table 4-18. Input/Output PWA Test Points



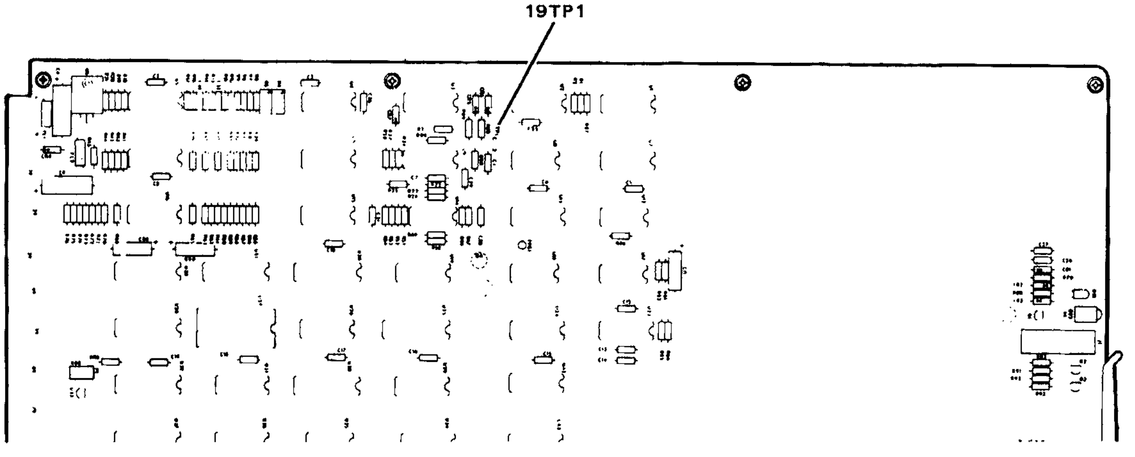
Test Point	Function
TP101	Control knob tach phase B
TP102	Control knob tach phase A
TP103	Control knob brake voltage (+24 Vdc)
TP104	Regulated +5 Vdc
TP105	Lamp voltage (+12 Vdc)
TP106	F1 output of decoder U132 (enables U121/U128)
TP107	F2 output of decoder U132 (enables U117/U119)
TP108	F3 output of decoder U132 (enables U113/U115)
TP109	F4 output of decoder U132 (enables U122/U125)
TP110	Regulated −12 Vdc
TP111	Regulated +12 Vdc

Table 4-19. Reference Generator (1467220 and 1457217) PWA Test Point



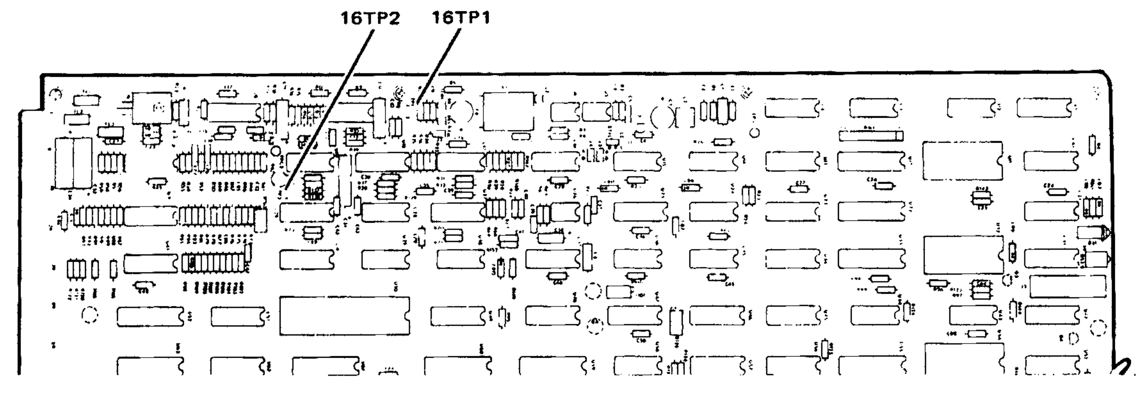
Test Point	Function
16TP1	Error voltage to 128H oscillator. Range is −20 Vdc to 0 Vdc (−5 Vdc when locked).

Table 4-20. Tape Remaining PWA Test Point



Test Point	Function
19TP1	Selected tension arm error (supply or takeup) to tape remaining computation logic. Tape remaining on supply reel measured during forward tape travel. Tape remaining on takeup reel measured during reverse tape travel.

Table 4-21. Reference Generator PWA (1467160 and 1467163) Test Points



Test Point	Function
16TP1	Error voltage to 128H oscillator. Range is −20 Vdc to 0 Vdc (−5 Vdc when locked).
16TP2	Selected tension arm error (supply or takeup) to tape remaining computation logic. Tape remaining on supply reel measured during forward tape travel. Tape remaining on takeup reel measured during reverse tape travel.

Table 4-22. NTSC Color Frame Detector PWA Test Points

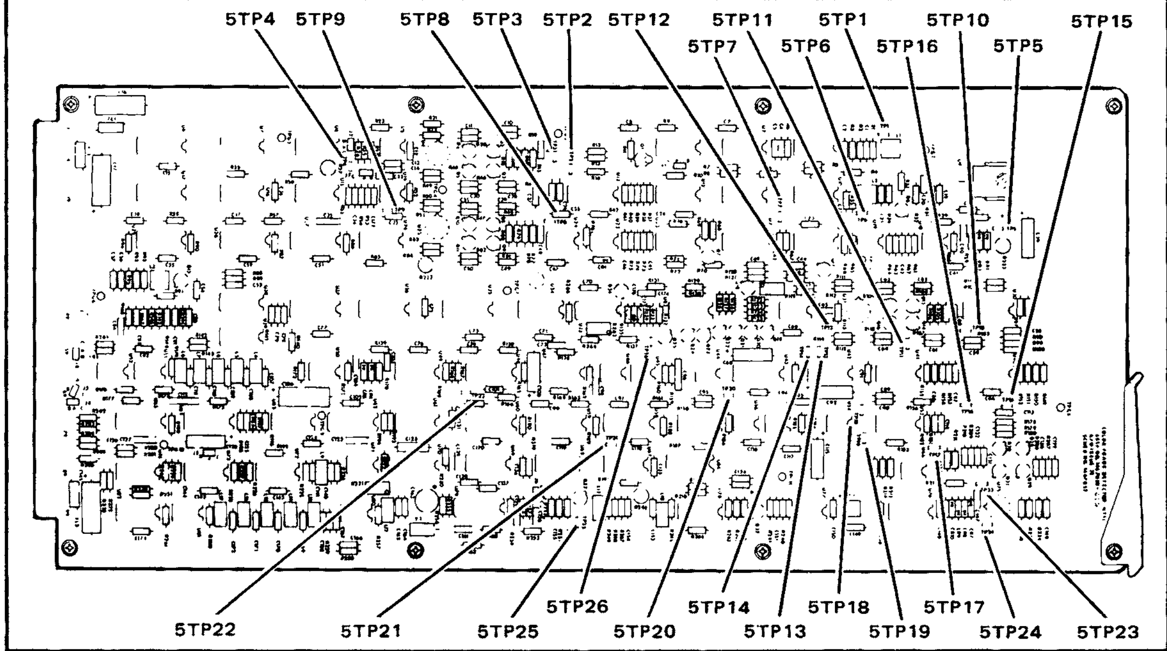


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Table 4-22. NTSC Color Frame Detector PWA Test Points (Continued)

Test Point	Function
5TP1	2Fsc output of 4Fsc-to-H divider (divide by 910)
5TP2	Second set of four burst zero crossings (positive-going)
5TP3	Fsc (horizontally derived)
5TP4	Color frame detector
5TP5	Feedback error to lock 4Fsc divider to demod H (0 Vdc when locked)
5TP6	Demod video chroma amplifier output
5TP7	Burst gate
5TP8	Fsc isoceles generator input to ScH phase error detector
5TP9	ScH error to meter
5TP10	Demod video sync sliced at 50% point
5TP11	20-ns pulse at H time
5TP12	15-kHz ramp to 4Fsc-to-H divider lock circuit
5TP13	Demod video 2H (half line) eliminate pulse
5TP14	Filtered demod video
5TP15	ScH phase sample pulse (fast pulse at H time)
5TP16	Selected reference video sliced at 50% point
5TP17	60-μs 2H eliminator and noise gate
5TP18	Selected reference video input to 50% sync slicer
5TP19	Reference video trigger to 50% slicer
5TP20	Demod video trigger to 50% slicer
5TP21	Selected reference video composite sync
5TP22	Demod video composite sync
5TP23	Voltage at high or low of 7.8-kHz square wave
5TP24	Reference phase shifted Fsc to ScH phase detector
5TP25	Reference Fsc output of chroma processor
5TP26	ScH meter calibration voltage

SECTION 5

SERVO SYSTEM

5-1 INTRODUCTION

This section provides a brief description of the VPR-3 servo system, and includes adjustment procedures.

5-2 SERVO SYSTEM

The servo system, shown in simplified form in Figure 5-1, controls tape speed and direction, scanner speed, takeup and supply reel motor speed, and AST head movement. Paragraphs 5-3 through 5-6 describe the following servo subsystems:

- Scanner servo
- Capstan servo
- Reel servos
- AST servo

5-3 Scanner Servo

The scanner servo controls scanner motor speed and phase. Outputs from a scanner tachometer circuit are compared to a reference frequency derived from vertical sync. Any deviation in scanner rotational position with respect to reference phase results in an error voltage applied as a correction to the scanner motor drive amplifier (MDA). A simplified block diagram of the scanner servo is shown in Figure 5-2.

The brushless dc motor is driven by current supplied from a motor drive amplifier (MDA) on the Capstan and Scanner MDA PWA. Current is developed from the scanner positional error signal generated on the Reel and Scanner Servo PWA. The error signal is derived by comparing the high-resolution tach signal (generated by the scanner tachometer) with the 24-kHz (20-kHz) signal produced by the VCO. The frequency of the VCO is controlled by an error signal developed from the phase difference between the once-around vertical tach and the scanner reference vertical produced on the Reference PWA.

The scanner's high-resolution tach signal is supplied by an optical tachometer that comprises a glass disk mounted on the scanner shaft, LED photo emitters, and photo diode receivers. On the disk periphery is a track that consists of a striated pattern of 400 opaque and clear segments. See Figure 5-3. As the scanner rotates, the pattern on the disk, passing between a photo-emitter/photo-receiver circuit, makes and breaks a light beam. This produces the high-resolution tach, a 24-kHz signal (20 kHz in 625-line standards). The once-around tach signal is

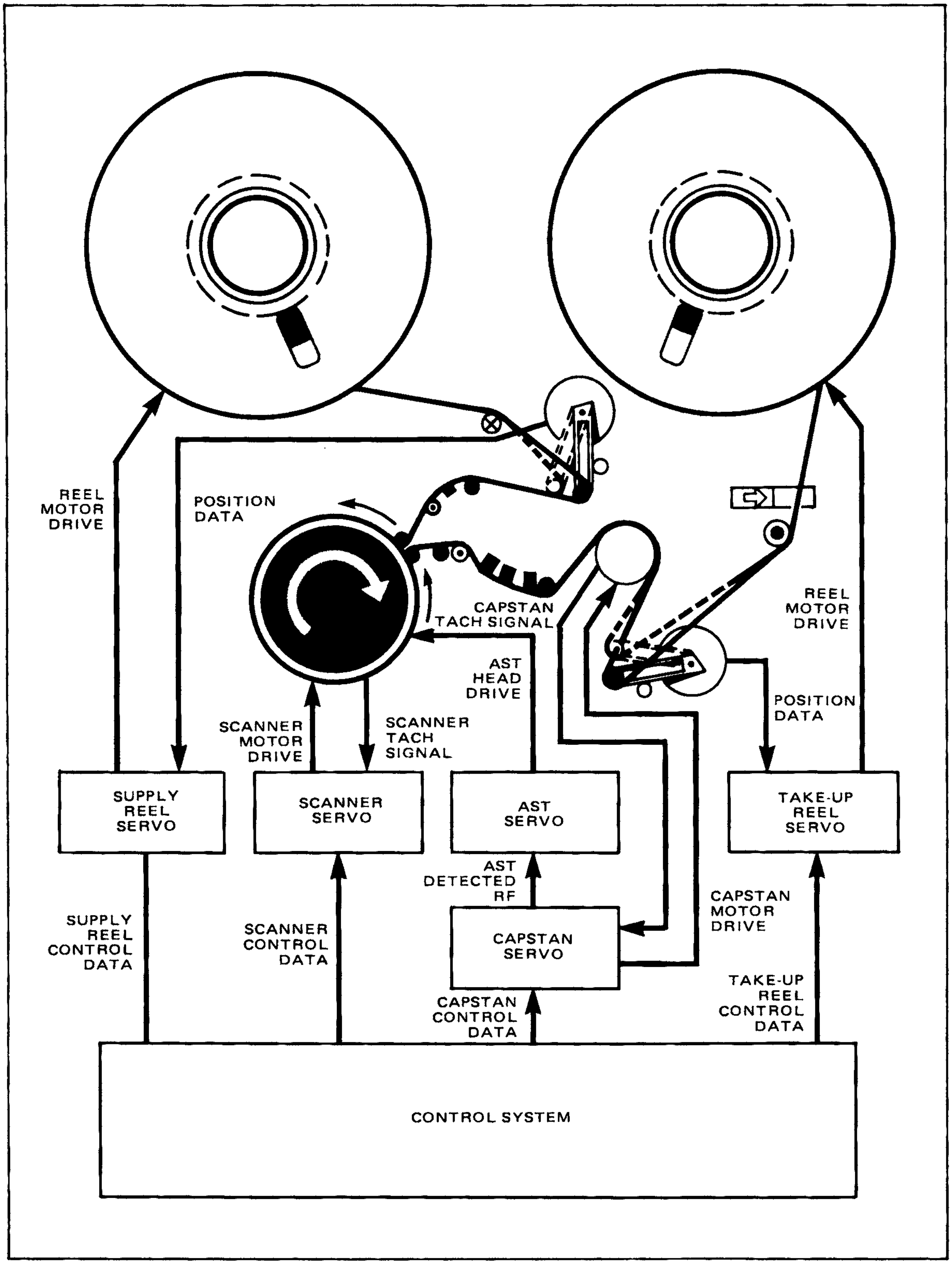

Figure 5-1. VPR-3 Servo System

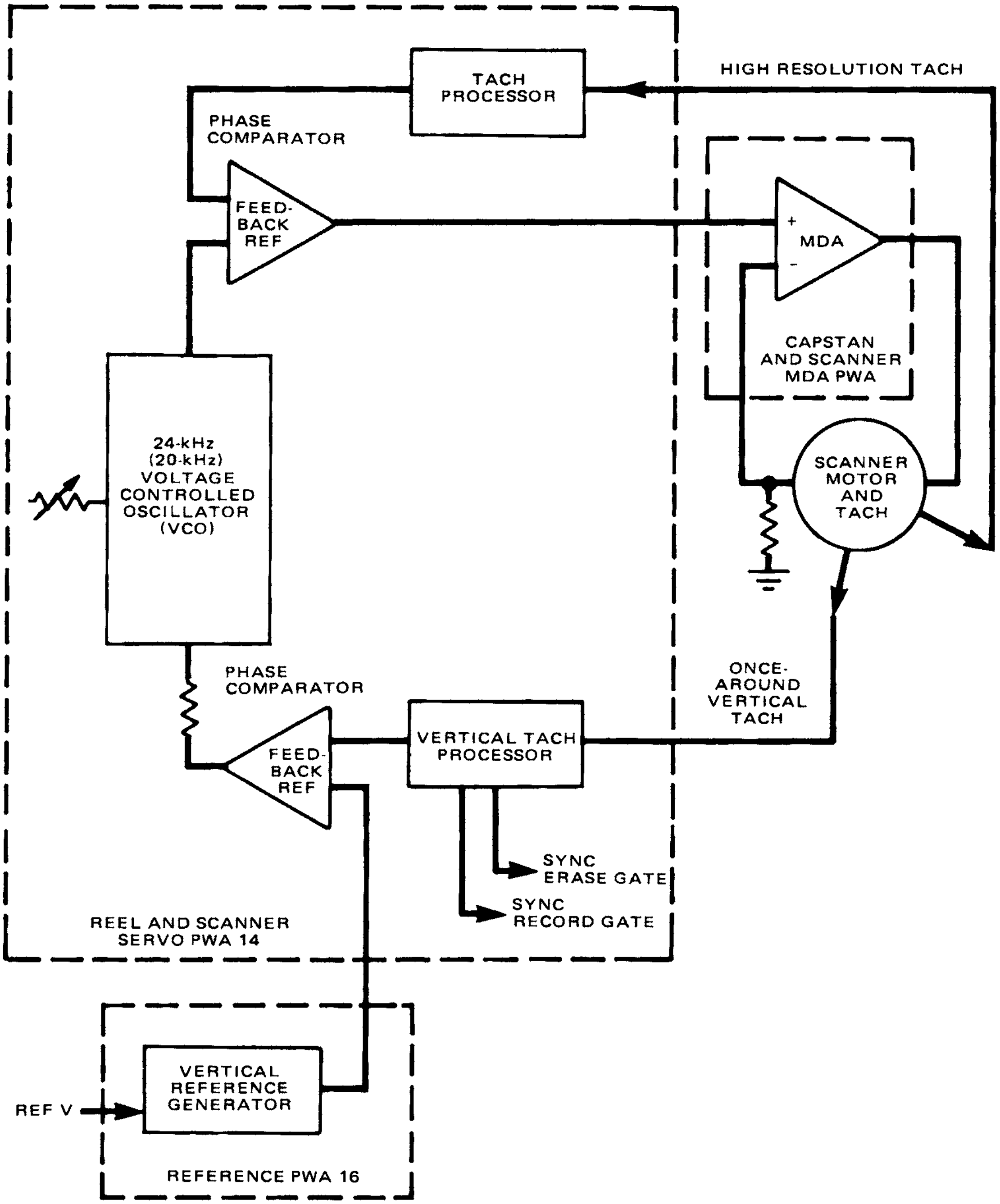

Figure 5-2. Scanner Servo

similarly produced. The once-around vertical tach, the sync-erase gate, and the sync-record gate are generated by a pattern of three windows spaced 120 degrees apart around the glass disk. The disk also has a track consisting of 12 windows used to generate commutation signals for the brushless dc motor. A detailed block diagram of the scanner servo system is given in Figure 5-4. Figure 5-5 is a simplified block diagram that shows details of the VCO and digital phase comparator that produce the error signal applied to the MDA.

5-4 Capstan Servo

The capstan servo subsystem, shown in Figures 5-6 and 5-7, controls capstan servo speed and direction. In a way similar to the scanner servo, the capstan servo controls capstan speed using horizontal sync as a frequency reference. A digital comparator compares capstan tachometer output frequency to reference, and generates a servo error signal which is applied to the capstan MDA. Unlike the scanner servo, the capstan servo has a variable play speed circuit which allows capstan (and tape) speed to vary from 3X forward to 1X reverse normal play speed. In addition, capstan position information is furnished to the AST servo. AST position is calculated from capstan position, AST error and reference vertical.

5-5 Reel Servo

This subsystem controls takeup and supply reel motor speed and direction. Reel motor drive is a function of tension arm position, and tape tension is essentially constant over the entire range of tension arm position. Takeup and supply reel servos are essentially identical, and maintain proper tape tensions at all operating tape speeds. Figure 5-8 is a servo circuit block diagram.

5-6 AST Servo

When in nonedit play modes, the automatic scan tracking (AST*) servo controls the transverse position of the video record/play head. The AST servo senses tracking errors by detecting variations in the off-tape rf envelope. A feedback arrangement alters the transverse position of the record/play head, so that it follows the center of the helical video track. Head deflection compensates for tape-speed-induced tracking errors in slow-motion and still-frame modes of operation. The head can be deflected ± 1 helical video track.

When the scanner is turning at lock speed (3600 or 3000 rpm), the video record/play head is applying 1000 G of force on a tape track 5 mils (0.127mm) wide and almost 17 inches (43cm) long. In normal play mode and with the scanner and capstan servos in both phase and velocity lock, the head completes the playback of one helical track (one field) and is moved relative to the tape to begin playback of the next field on the following track. In terms of time, the move from one track to the next occurs during the vertical interval. In terms of space, the move occurs when the omega-wrapped tape is not in contact with the scanner. Head-to-tape speed is the sum of the servo-locked tape and head (scanner) speeds. Therefore, at normal play tape speed, mistracking error is limited to a function of head wear and scanner geometry.

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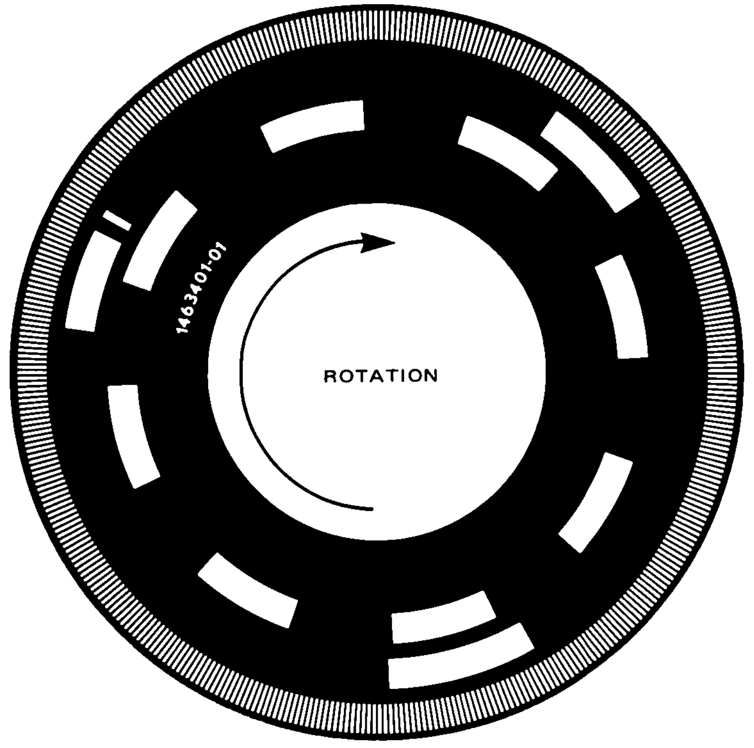
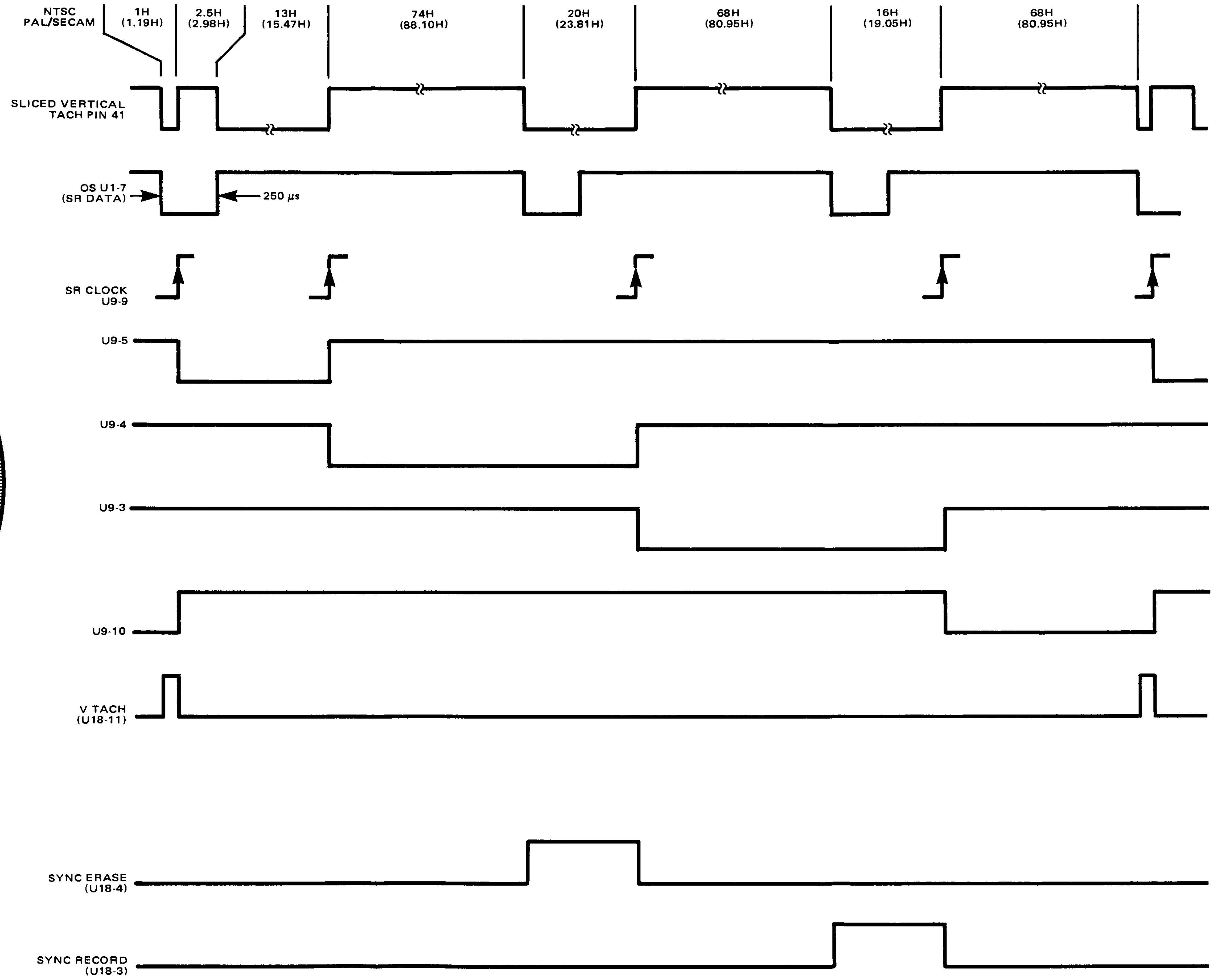
*Trademark Ampex Corporation



SCANNER TACH DISC



DRAWING NOT TO SCALE

**Figure 5-3.
Scanner Tach Signals**

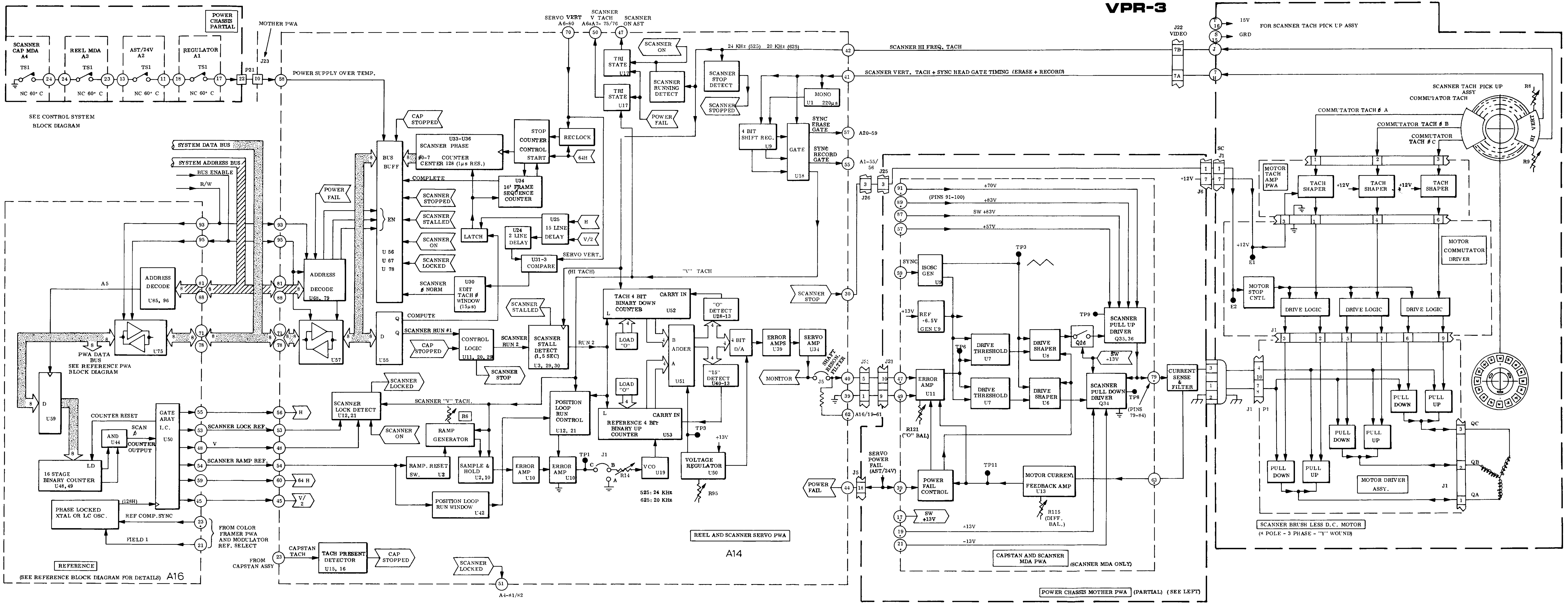


Figure 5-4. Scanner Servo System Detailed Block Diagram

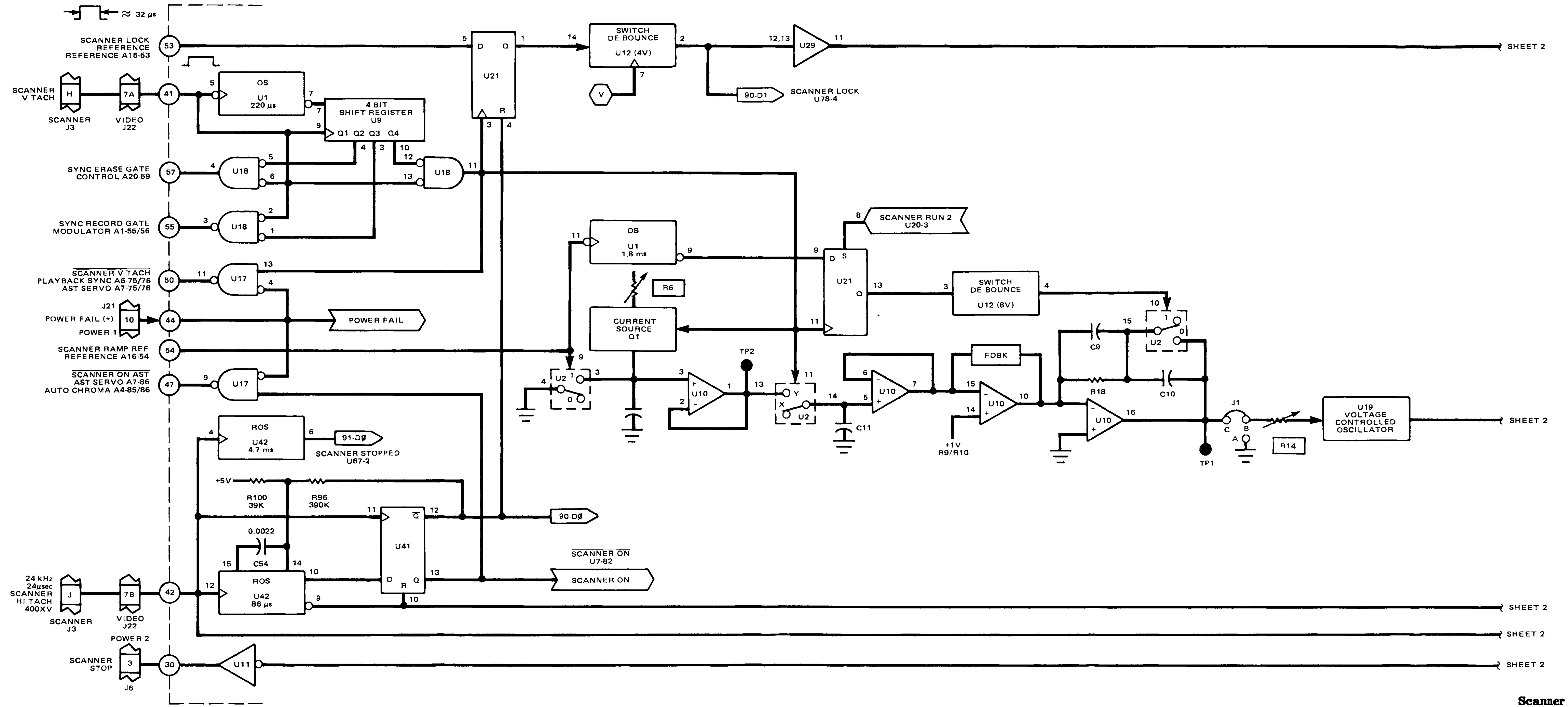


Figure 5-5.
Scanner Servo Error Generation
Simplified Schematic Diagram
(Sheet 1 of 2)

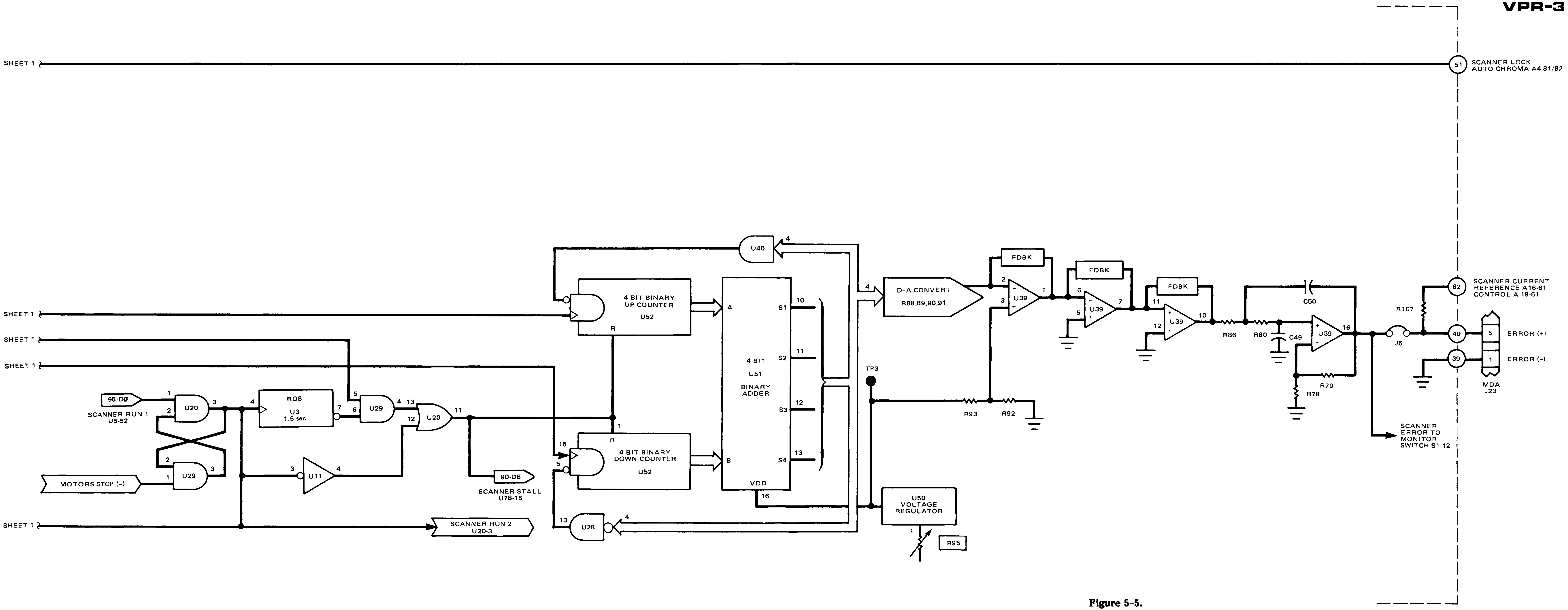


Figure 5-5.
Scanner Servo Error Generation
Simplified Schematic Diagram
(Sheet 2 of 2)

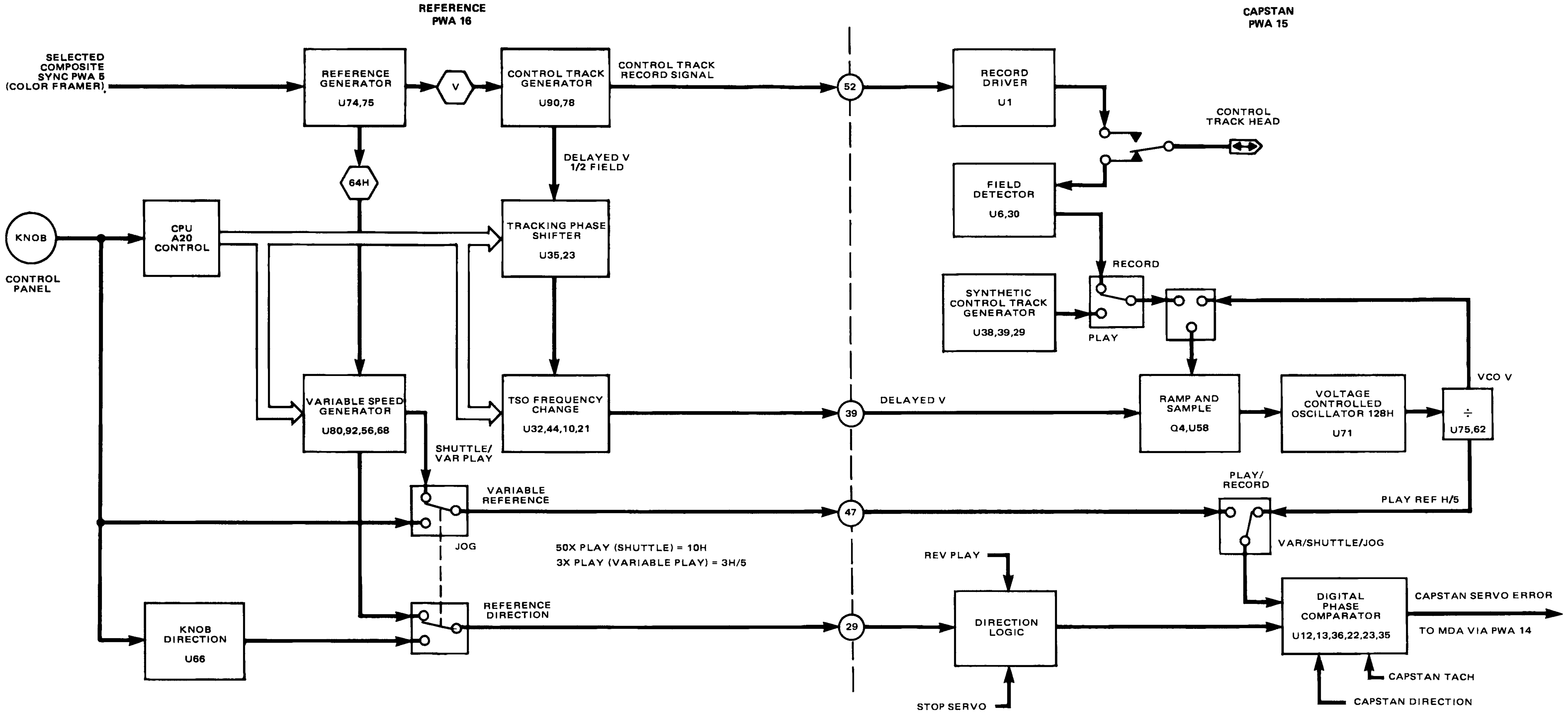


**Figure 5-6.
Capstan Servo System
Simplified Block Diagram**

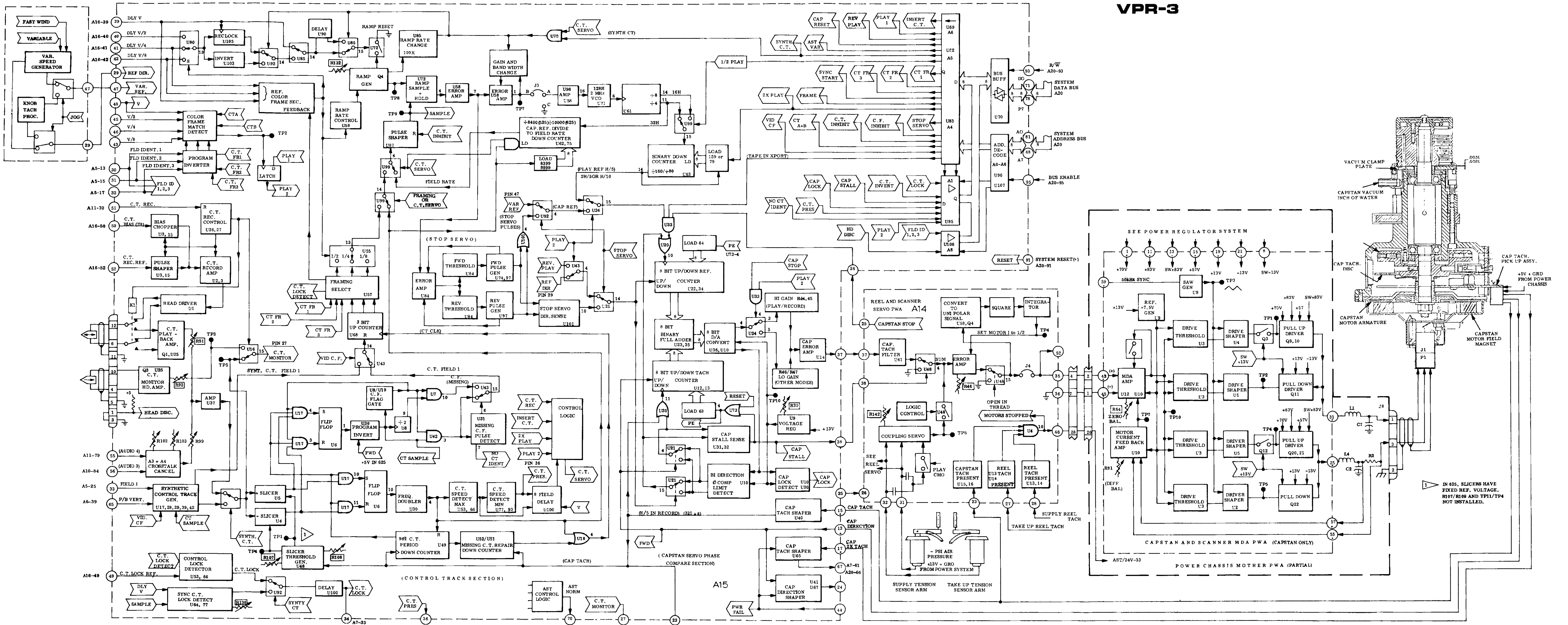


Figure 5-7.
Capstan Servo System
Detailed Block Diagram

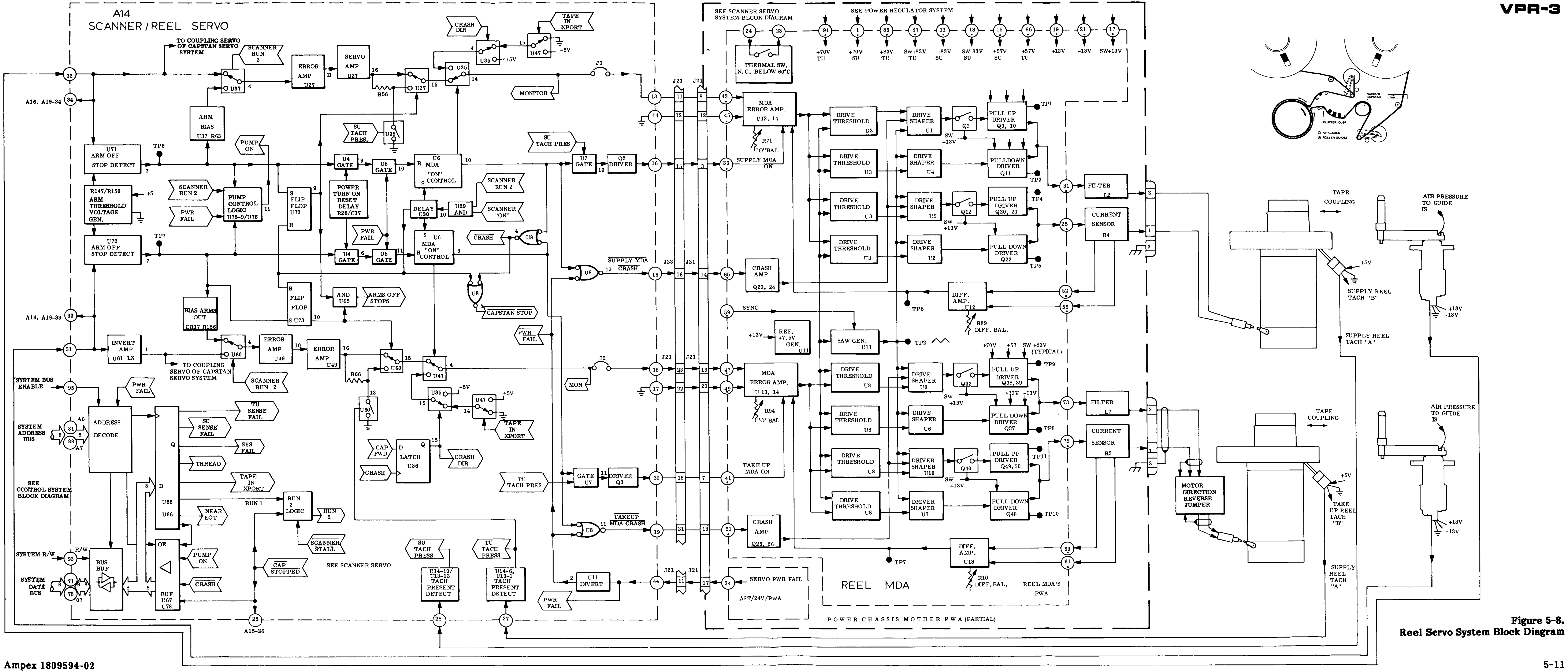


Figure 5-8.
Reel Servo System Block Diagram

If, however, tape speed is reduced from normal play speed to still-frame playback, head-to-tape speed is reduced until it is composed solely of the head speed. Without AST, the result is mistracking as shown by the heavy black line in Figure 5-9. In this operating mode, the head travels further into the guard band as tape speed is reduced, and helical noise bars appear in the picture.

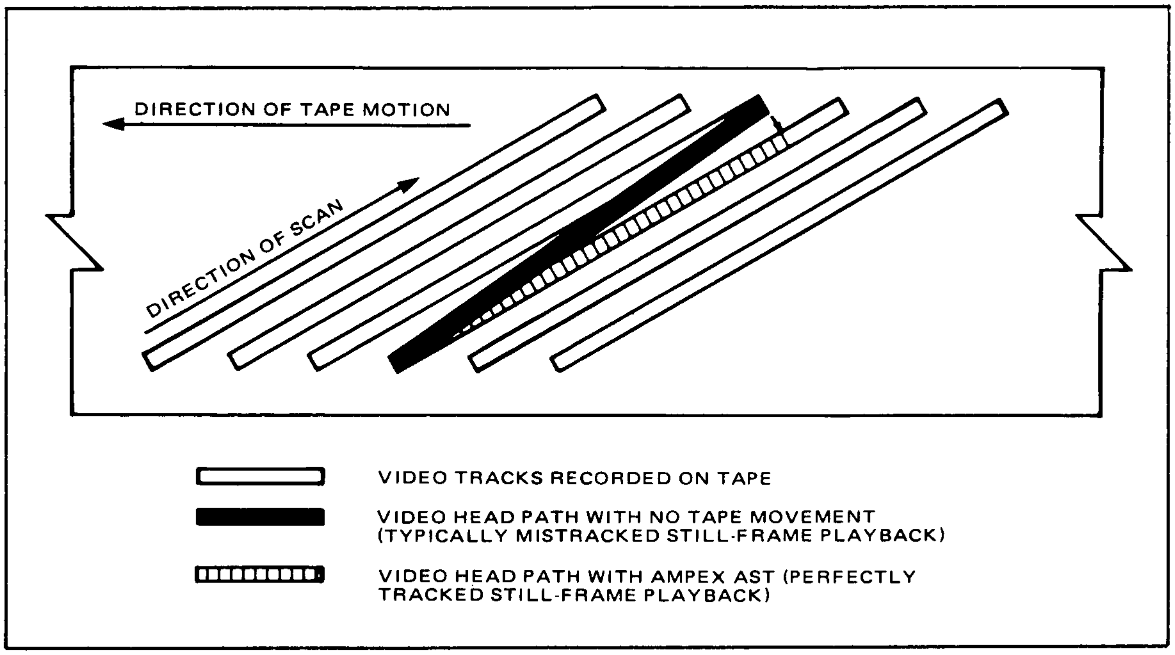

DIRECTION OF TAPE MOTION
DIRECTION OF SCAN
VIDEO TRACKS RECORDED ON TAPE
VIDEO HEAD PATH WITH NO TAPE MOVEMENT (TYPICALLY MISTRACKED STILL-FRAME PLAYBACK)
VIDEO HEAD PATH WITH AMPEX AST (PERFECTLY TRACKED STILL-FRAME PLAYBACK)

Figure 5-9. Video Tracks on Tape with and without AST

The AST servo keeps the video head in the center of the helical track by flexure of the bimorphic deflector element upon which the head is mounted. The deflector element is composed of layers of piezoelectric ceramic bonded in a sandwich on each side of a ground electrode. Gold-plated nickel electrodes are bonded to the outside surfaces of the piezoelectric ceramic layers. A sectional view of this construction is shown in Figure 5-10. Ceramic layers and their electrodes bend when voltage is applied. Thus, the head, affixed to the bimorphic element, deflects and thereby describe a different track. The head can be deflected 0.5mm, or ± one track. When the head reaches the limits of deflection, the AST servo causes the head to jump to the adjacent track during the next vertical interval, and color framing is maintained.

Tracking guidance is provided by dithering the head and comparing the dither phase with the amplitude and phase errors of recorded video. Both error amplitude and direction are determined without impairing the video signal.

An exploded view of the Ampex AST head assembly is shown in Figure 5-11. Note that both upper and lower nickel electrodes are split lengthwise and across the width. The wider lengthwise portion is used to deflect the head. The narrow lengthwise portion is the sense strip which indicates degree of deflection to the AST servo, and also provides a means of electrical damping.

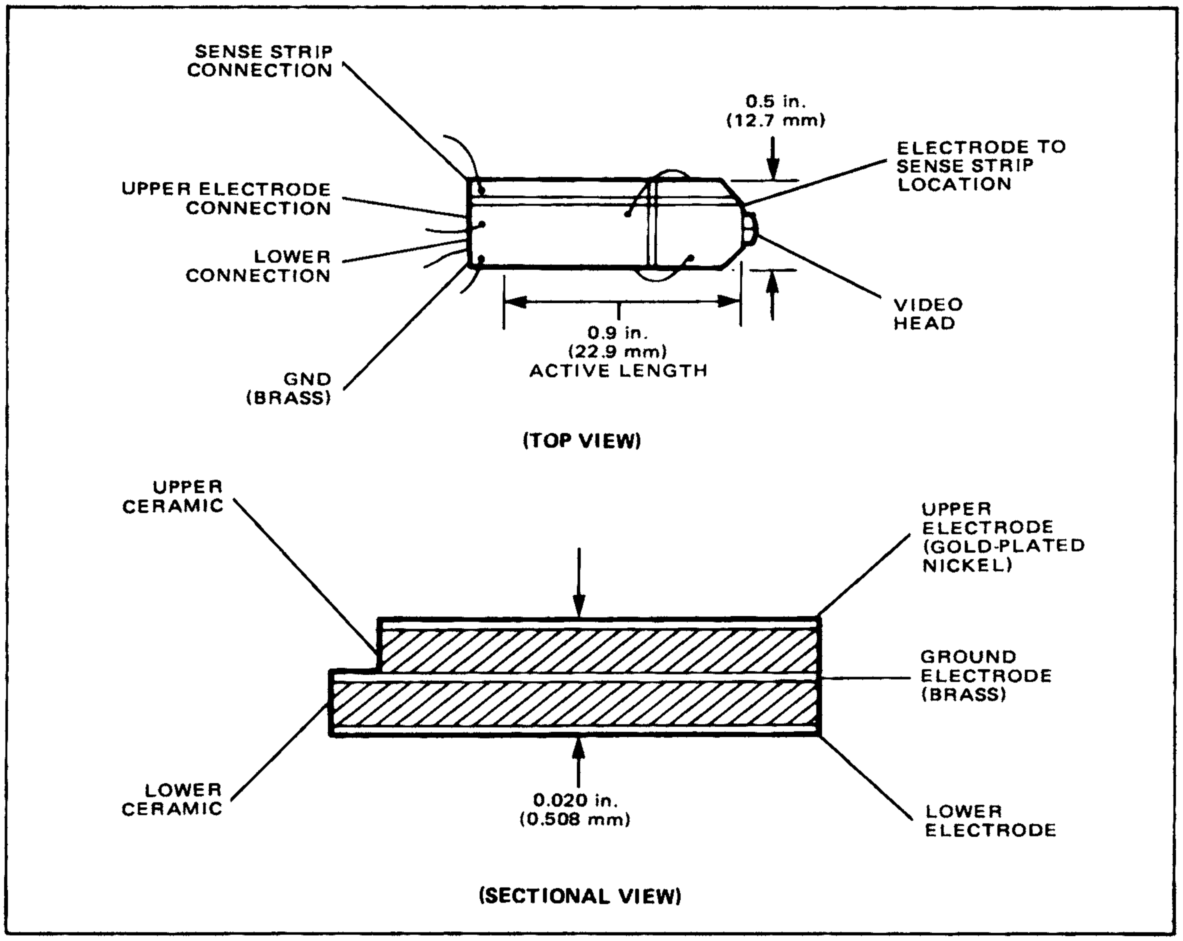


Figure 5-10. AST Head—Cross Section

At normal playback speeds the AST element theoretically does no work. However, as an AST element and head deflect to extremes in slow-motion playback, azimuth errors appear. The head begins to lose contact with the tape as the element is deflected. Therefore, the nickel electrodes are split crosswise, and inputs to the electrode segments near the head are reversed. Thus, the element articulates in an "S" curve as it deflects. This recurving maintains correct head-to-tape contact at all degrees of flexure.

The piezoelectric elements must be polarized; in normal operation positive and negative voltages cause up and down deflection. To prevent depolarization, a separate deflection voltage of the proper polarity is used for each electrode of the bimorphic deflector, ensuring that piezoelectric elements are never driven in the opposite direction of polarization.

The AST servo is three servos in one. The first is a static (dc) servo which takes care of elevation differences between record and reproduce heads. The second is for dynamic (ac) correction, which actively follows the video track. The third is look-ahead logic which compares the instantaneous head position with the next

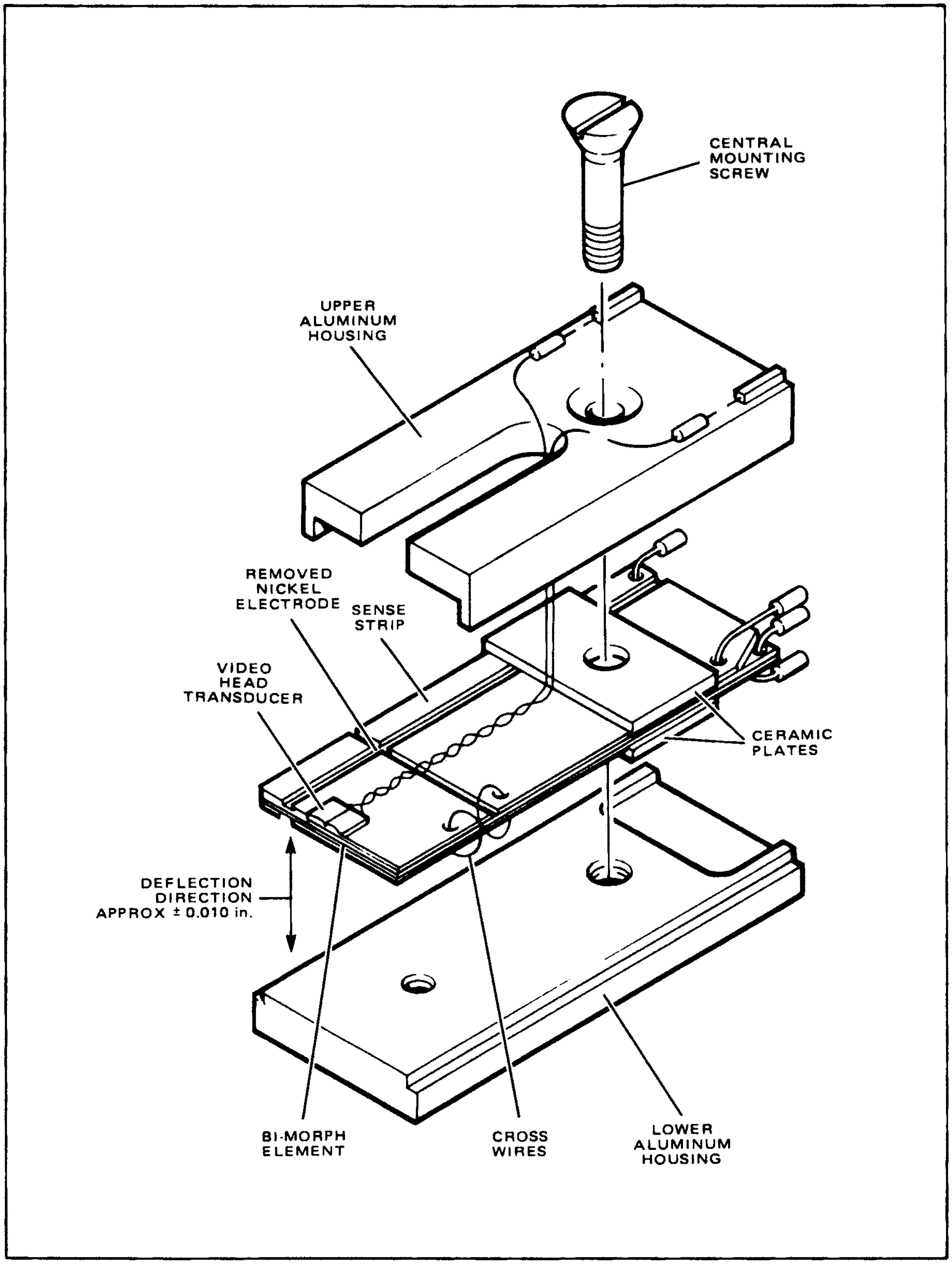


Figure 5-11. AST Head—Exploded View

position. This logic decides when it is time to leave one track and jump to the next track in the vertical interval. A simplified schematic diagram of the AST system is given in Figure 5-12.

5-7 SERVO SYSTEM ALIGNMENT PROCEDURES

Procedures outlined in the paragraphs that follow cover adjustments that do not need special factory test fixtures. These adjustments are not required on a routine basis, and should be performed only if components have been replaced, or if there are indications of degraded performance when tapes are interchanged. Before performing any adjustments, be sure that the VPR-3 is at an ambient temperature close to its normal operating environment.

5-8 Servo System Jumpers

Functions of jumpers used on the PWAs in the video signal system are listed in Table 5-1.

5-9 Servo System Test Points

Signals available at test points provided on PWAs in the servo system are described in Table 5-2.

5-10 Reel Servo System Adjustments

STEP 1 With power off, place Scanner Reel Servo PWA 14 on extender. Turn power on.

a. Connect scope to PWA 14 pin 31. Move takeup tension arm from the left to the right mechanical stops. Voltage should swing from +5 ±0.1V to -5 ±0.1V.

b. Move scope to PWA 14 pin 32 and move supply tension arm from one mechanical stop to the other. Voltage swing should be from +5 ±0.1V to -5 ±0.1V.

   - If these parameters are not met, adjustment of mechanical stops or tension arm sensors will be necessary.
   - End stops on both tension arms are eccentric cams which provide a vernier trim to equalize the two voltages.

c. If adjustment is required, remove transport cover trim.

d. If any of the above voltages is incorrect, loosen mechanical stop, and try to adjust eccentric cam to bring voltage into correct range.

e. If mechanical stops do not have enough range, place the two associated with the misadjusted arm to the mechanical center.

   - Two adjustable resistors, R1 and R5, are located on the back of each of the tension arm assemblies.
   - Adjust R5 for a range of ±5V, and R1 offset control for correct voltage at each of the mechanical stops.

- Since supply arm assembly is located behind air package, it is necessary to remove tension arm assembly, make a trial adjustment, replace it, and verify that the trim was correct.

STEP 2 With power off, place Tape Remaining PWA 19 on extender, and turn power on.

a. Move scope to PWA 19 pin 28. Manually turn capstan counterclockwise, and verify that pin 28 is low.

b. Move scope to PWA 19 TP1. Move takeup tension arm from one mechanical stop to the other. If necessary, adjust PWA 19 R4 to give a 6-Vp-p swing.

c. Return scope to PWA 19 pin 28, and turn capstan clockwise, observing that pin 28 voltage is high.

d. With scope on PWA 19 TP1, swing supply tension arm from one mechanical stop to the other. If necessary, adjust R5 for a 6.4-Vp-p swing.

CAUTION

ALWAYS REMOVE POWER WHEN REMOVING OR INSTALLING PRINTED WIRING ASSEMBLIES (PWAs). WAIT A MINIMUM OF 30 SECONDS AFTER TURNING OFF POWER BEFORE REMOVING OR REPLACING A PWA IN THE POWER CHASSIS ASSEMBLY. SAFETY GLASSES SHOULD BE WORN WHEN SERVICING POWER CHASSIS ASSEMBLY.

STEP 3 On Reel MDA PWA 3, R89 (supply) and R10 (takeup) differential balance adjustments are set using a factory fixture. To adjust zero balance controls:

a. Remove tape from transport. Remove jumpers J3 and J2 on Reel and Scanner PWA 14, and return PWA 14 to card cage.

b. Place Reel MDA PWA 3 on extender.

Trigger: pin 59

Connect: CH1 to TP1
CH2 to TP4

c. Place a spacer between the two tension arms and their stops (an IC clip is recommended). Block tape in transport sensor mounted on video erase assembly. Turn on power, and enter play mode.

d. Ground pin 43 or pin 44 of Reel MDA PWA 3, and adjust R71 until no pulses occur at TP1 or TP4. Remove ground from pin 43/44.

Trigger: pin 59

Connect: CH1 to TP9
CH2 to TP11

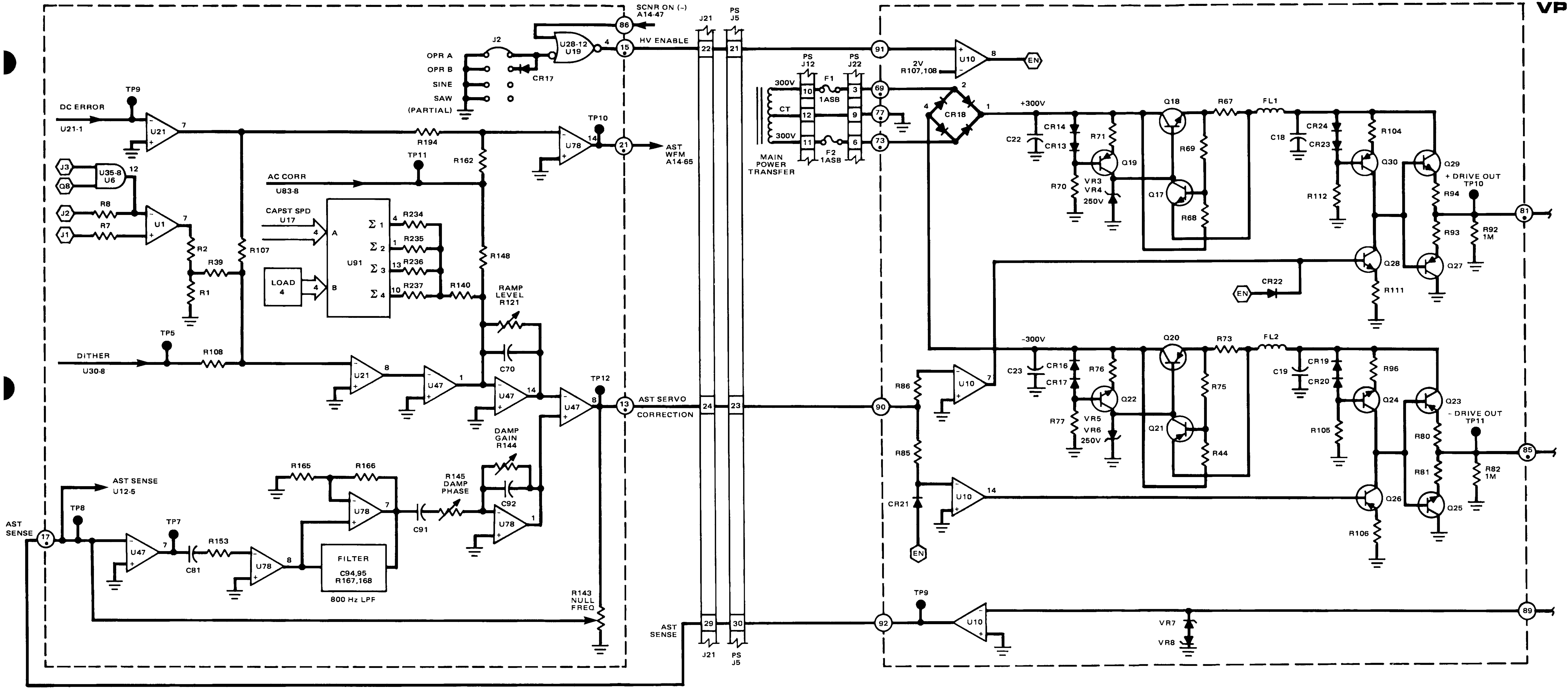


Figure 5-12.
AST Driver Simplified Schematic
(Sheet 1 of 2)

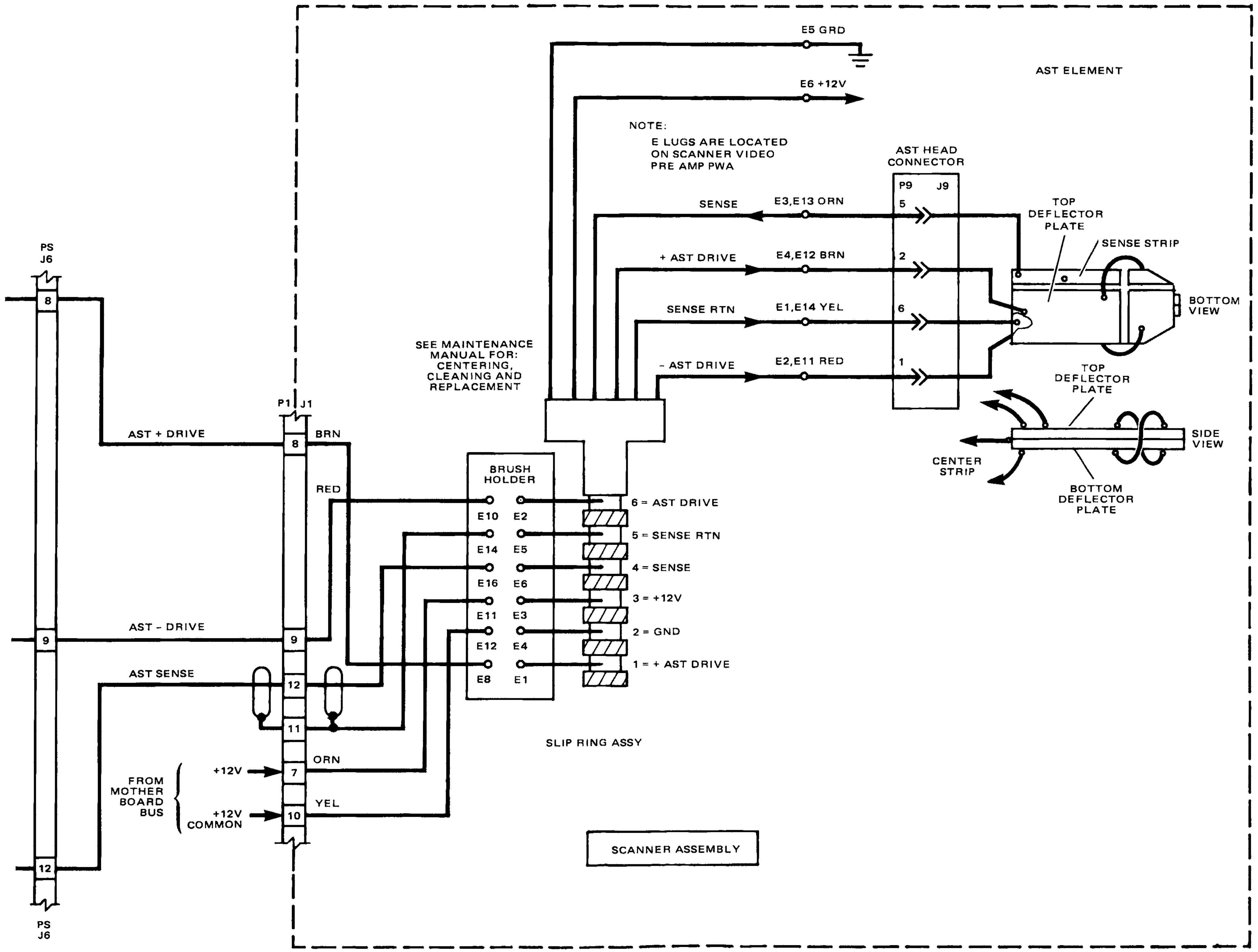


Figure 5-12.
AST Driver Simplified Schematic
(Sheet 2 of 2)

Table 5-1. Servo System Jumpers

Jumper	Position	Function
AST Servo PWA A7		
J1	FRM/NORM	Places true frame mode in the normal two fields/track jump mode.
	FRM/STAG	Allows frame jumps to be made over consecutive fields. Valid only from 3/4 to 1-1/4 x normal speed.
J2	OPR A	Normal operating (non-step) position.
	OPR B	Used for setup. Permits normal operation with exception that dynamic correction is disabled for ease of setup.
	SINE	Used during AST head setup only; sine wave for nulling head resonant.
	RAMP	Used during AST head setup only; still frame ramp
Reel and Scanner Servo PWA		
J1		Scanner position loop error signal
	B-C	Normal
	A-C	Test
J2		Take up reel servo loop
	In	Normal
	Out	Test, disables takeup reel MDA drive current.
J3		Supply reel servo loop
	In	Normal
	Out	Test, disables supply reel MDA drive current.
J4		Capstan servo loop
	In	Normal
	Out	Test, disables capstan MDA drive current.
J5		Scanner servo loop
	In	Normal
	Out	Test, disables scanner MDA drive current.
Control Track and Capstan Servo PWA 15		
J3		Control track servo loop
	A-B	Normal
	A-C	Test; grounds error input into voltage controlled oscillator (VCO).

Table 5-2. Servo System Test Points

Test Point	Signal
AST Servo PWA 7	
TP1	Synchronous detector error
TP2	Detector reference 355 Hz TTL
TP3	Scanner tach
TP4	Detected rf
TP5	455-Hz digital sine wave
TP6	Capstan tach
TP7	AST sense strip null
TP8	AST sense strip output
TP9	AST correction ramp
TP10	AST correction signal to waveform monitor
TP11	AC error correction voltage
TP12	AST servo correction
TP13	Dither amplitude control
Reel and Scanner Servo PWA 14	
TP1	Scanner position loop VCO error
TP2	Scanner position loop error
Reel and Scanner Servo PWA 14 (Con't)	
TP3	+5V regulator output
TP4	Capstan current limit
TP5	Tension arm coupling to capstan servo
TP6	Supply tension arm sense
TP7	Takeup tension arm sense
Control Track/Capstan Servo PWA 15	
TP1	Control track sampling level
TP2	Control track field match
TP3	Control track monitor head output
TP4	Control track sampling level
TP5	Playback control track
TP6	Control track phase error
TP7	Control track servo error
TP8	Control track servo ramp
TP9	Control track servo sample pulse
TP10	+5V regulator output

e. Ground pin 47 or 48, and adjust R94 until no pulses occur at TP9 or TP11.

f. Turn off power. Replace Reel MDA PWA 3 into slot.

g. On Reel and Scanner PWA 14, replace J2 and J3. Remove tape in transport sensor block, and spacers from the tension arms.

STEP 4 Certain faults in the Reel MDA PWA can cause FET drivers to fail. The following procedure is useful in troubleshooting, and is applicable to all MDAs by substitution of correct test points, etc.

a. Remove P-channel FETs Q20, Q21, Q49, and Q50.

b. Install test jumpers J1 and J2.

c. Connect oscilloscope to TP4 and TP5, triggering from PWA pin 59.

d. Enable reel servos by holding tension arms in the center of their range. Waveforms should appear as shown below. Moving the tension arm should change pulse width at TP4. Voltage at TP5 should swing equally positive and negative.

e. Repeat steps 3 and 4 for the takeup arm, using TP10 and TP11.

f. Remove test jumpers J1 and J2, and replace P-channel FETs.

5-11 Control Track and Capstan Servo Alignment

For the following control-track-level adjustments, place Control Track and Capstan Servo PWA 15 on extender. Play a prerecorded tape:

STEP 1 Control track monitor level R92.

Trigger: Pin 45 (V/2)

Connect: CH1 to TP3

Adjust: R92 for 1 ±0.1 Vp-p

STEP 2 Control track playback level.

Connect: CH1 to TP5

Adjust: R91 for 1 ±0.1 Vp-p.

STEP 3 Slice level (525 standards only):

Connect: CH1 to TP4

Adjust: 15R107 for -0.025 Vdc in stop/ready off mode

Connect: CH1 to TP1

Adjust: 15R108 for +0.025 Vdc in stop/ready off mode.

STEP 4 Control track record level (625 standard only); set playback gain using standard tape:

Connect: CH1 to TP3

Mode: Record

Adjust: R174 for 1 Vp-p

STEP 5 VCO adjustment:

Meter: TP10

Adjust: 15R30 for +5.0 Vdc

STEP 6 Jumpers: 15J3 A-C

Connect: CH1 to TP8 (trigger)
CH2 to TP9

Adjust: In E-E mode, C81 for minimum drift of TP9 with respect to TP8

STEP 7 Jumpers: Return 15J3 to normal A-B position

Mode: stop/ready off

Connect: CH1 to TP7

Adjust: C81 for 0V ±0.1V

STEP 8 Trigger: Pin 45

Connect: CH1 to TP6

Mode: Play back a prerecorded tape

Adjust: 15R132 for minimum pulse width (normally less than 20 µs)

STEP 9 Synthetic control track lock detect:

Trigger: PWA 15 pin 39 (delayed V)

Connect: CH1 to U77-3 (TP9)
CH2 to U77-5

Mode: Select synthetic control track on Servo Setup More menu and play back a prerecorded tape

Adjust: 15R138 so positive edge of pulse at U77-3 is in center of pulse at U77-5. Remove PWA 15 from extender and replace in card slot.

STEP 10 Capstan error offset is on Reel and Scanner PWA 14. Place PWA 14 on extender.

Mode: Stop, not ready

Simulate capstan stall: Connect PWA 14 pin 38 to +5 Vdc

Scope: 14U48-2

Adjust: 14 R46 for 0 Vdc

STEP 11 Connect: CH1 14U48-2

Mode: Ready

Adjust: 14R142 for 0V

CAUTION

ALWAYS REMOVE POWER WHEN REMOVING OR INSTALLING PRINTED WIRING ASSEMBLIES (PWAs). WAIT A MINIMUM OF 30 SECONDS AFTER TURNING OFF POWER BEFORE REMOVING OR REPLACING A PWA IN THE POWER CHASSIS ASSEMBLY. SAFETY GLASSES SHOULD BE WORN WHEN SERVICING POWER CHASSIS ASSEMBLIES.

STEP 12 Place Capstan and Scanner MDA PWA 4 on extender. Capstan differential balance R81 requires a factory fixture to adjust. Zero balance is set as follows:

Connect: Trigger from sync, pin 59
CH1 to TP4
CH2 to TP1

Mode: Stop, not ready

Adjust: R64 until no pulses are present on either channel

Note: Check first that pin 43 is at 0V. Turn off power and replace Scanner and Capstan MDA PWA 4

5-12 Scanner Servo Adjustments

STEP 1 With power off, place Reel Scanner Servo PWA 14 on extender.

STEP 2 Digital-to-analog converter reference voltage:

Connect: DVM to TP3

Adjust: 14R95 for +5V ±10 mV

STEP 3 Voltage-controlled oscillator (VCO) adjustment is necessary only if a component in area of VCO 14U19 has been replaced, or serious misadjustment has occurred:

Connect: CH1 to pin 53 (trigger): scanner lock reference
CH2 to pin 50; scanner vertical tachometer

Jumper: 14J1 A-B

Mode: Ready

Coarse adjust: 14R14 until pin 50 is same frequency as pin 53

Jumper: Restore J1 to normal B-C position

Connect: CH1 to TP1

Fine adjust: 14R14 for 0V

Adjust: 14R6 to put falling edge of signal on pin 50 in center of pulse on pin 53

STEP 4 To adjust scanner MDA balance, place Capstan and Scanner MDA PWA 4 on extender. Do not adjust differential balance R115, which is set using a special factory test fixture.

CAUTION

ALWAYS REMOVE POWER WHEN REMOVING OR INSTALLING PRINTED WIRING ASSEMBLIES (PWAs). WAIT A MINIMUM OF 30 SECONDS AFTER TURNING OFF POWER BEFORE REMOVING OR REPLACING A PWA IN POWER CHASSIS ASSEMBLY. SAFETY GLASSES SHOULD BE WORN WHEN SERVICING POWER CHASSIS ASSEMBLIES.

Mode: Stop, not ready

Jumper: Remove J5 and Scanner Reel Servo PWA

Connect: Trigger at pin 59 (sync)
CH1 to TP8
CH2 to TP9

Ground: Connect PWA 4 pin 47 or 48 to ground

Adjust: R121 zero balance so that no pulses are present at either test point. Turn power off, replace 14 J5, and return all boards to card cages.

SECTION 6
TRANSPORT ASSEMBLY

6-1 INTRODUCTION

This section describes the mechanical tape transport system and related components. Material covers general theory of operation, subassembly descriptions, and cleaning procedures, as well as removal, disassembly, and replacement of key subassemblies. VPR-3 diagnostics and error messages are given where applicable. The last part of this section covers interchange procedures and adjustments that affect interchangeability of video tapes among different VTRs.

Reference to appropriate schematics and drawings in the *VPR-3 Parts Lists and Schematics Manual* are noted where appropriate. Illustrations of subassemblies and critical adjustments are presented to show detail and provide better understanding of procedures.

Proper operation of the tape transport system requires particular attention to details such as:

- Tape tension throughout the system
- Air pressure and airflow in the air system
- Scanner entrance and exit guide positioning
- Longitudinal head stack position

Before removing parts of the transport system, you should make sure that the above items have been checked. Paragraph 6-25 describes how to check tape tension and air pressure/air flow. Starting with paragraph 6-48, the interchange procedure details guide positioning and longitudinal head stack position, in addition to other elements required for successful video tape interchange.

6-2 TRANSPORT SYSTEM—GENERAL DESCRIPTION

The tape transport system consists of a top plate with tape handling assemblies mounted on it, and recording, playback, and erase heads for the video, audio, control track, and optional sync systems. The air system, covered in Section 9, is integrated into the transport system. Figure 6-1 shows the tape transport system with protective trim removed. Figure 6-2 shows the back side of the top plate assembly with transport system components seen from rear.

Tape can be moved at speeds ranging from frame-by-frame movement to shuttle speeds up to 50X normal play speed, as well as in reverse direction. Figure 6-3 shows the tape path through the tape transport system. Details of the transport system are presented in schematic no. 1461200 in the *VPR-3 Parts Lists and Schematics Manual.*

6-3 General Description of Tape Movement

Tape from the supply reel first passes over a stationary fixed guide which provides initial edge guiding. The tape then contacts an air guide tension arm subassembly, which alters with tape direction and establishes supply reel tape tension. Next, the tape travels over a roller guide, a longitudinal video erase head, and a small diameter air guide, and then goes to the scanner assembly. Entrance and exit air guides (part of the scanner assembly) provide proper positioning of tape at the entrance to and the exit from the scanner guide band. Upon leaving the scanner, the tape passes over another air guide, and then over a flutter idler assembly. The

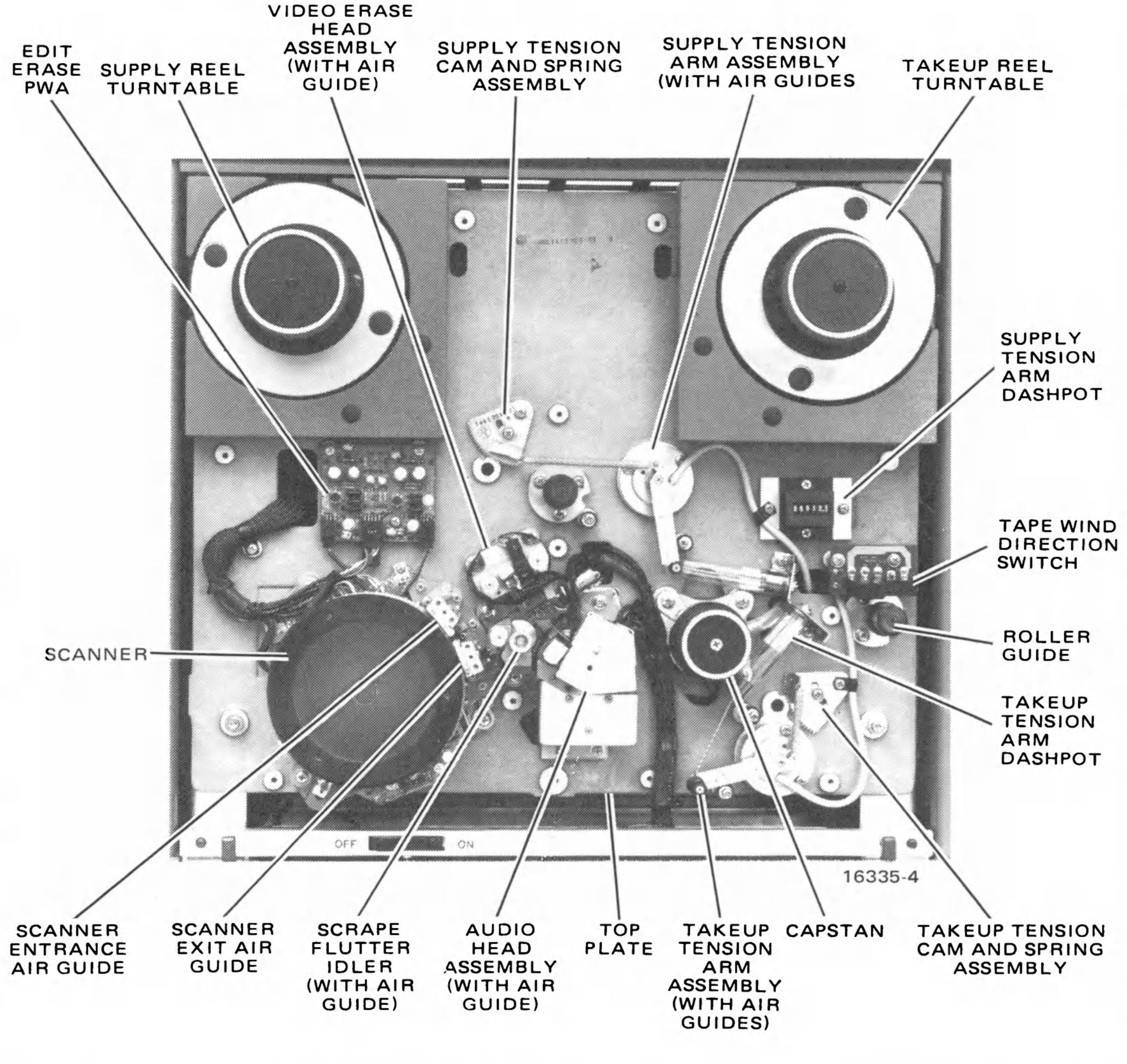

EDIT ERASE PWA
SUPPLY REEL TURNTABLE
VIDEO ERASE HEAD ASSEMBLY (WITH AIR GUIDE)
SUPPLY TENSION CAM AND SPRING ASSEMBLY
SUPPLY TENSION ARM ASSEMBLY (WITH AIR GUIDES
TAKEUP REEL TURNTABLE
SUPPLY TENSION ARM DASHPOT
TAPE WIND DIRECTION SWITCH
ROLLER GUIDE
TAKEUP TENSION ARM DASHPOT
SCANNER
OFF
ON
16335-4
SCANNER ENTRANCE AIR GUIDE
SCANNER EXIT AIR GUIDE
SCRAPE FLUTTER IDLER (WITH AIR GUIDE)
AUDIO HEAD ASSEMBLY (WITH AIR GUIDE)
TOP PLATE
TAKEUP TENSION ARM ASSEMBLY (WITH AIR GUIDES)
CAPSTAN
TAKEUP TENSION CAM AND SPRING ASSEMBLY

Figure 6-1. Transport Assembly with Protective Trim Removed

flutter idler isolates video head tip disturbance from the audio head stack, and stabilizes reverse direction tape movement. After moving across audio head stacks, the tape is passed over an air guide to the capstan. Tape is held against the capstan by vacuum, which is present during all operating modes. Tape leaving the capstan travels over an air guide tension arm subassembly, which changes with tape direction and establishes takeup reel tape tension. Tape then contacts a roller guide, which properly positions tape to the takeup reel in either A wind or B wind, as selected by a jumper plug.

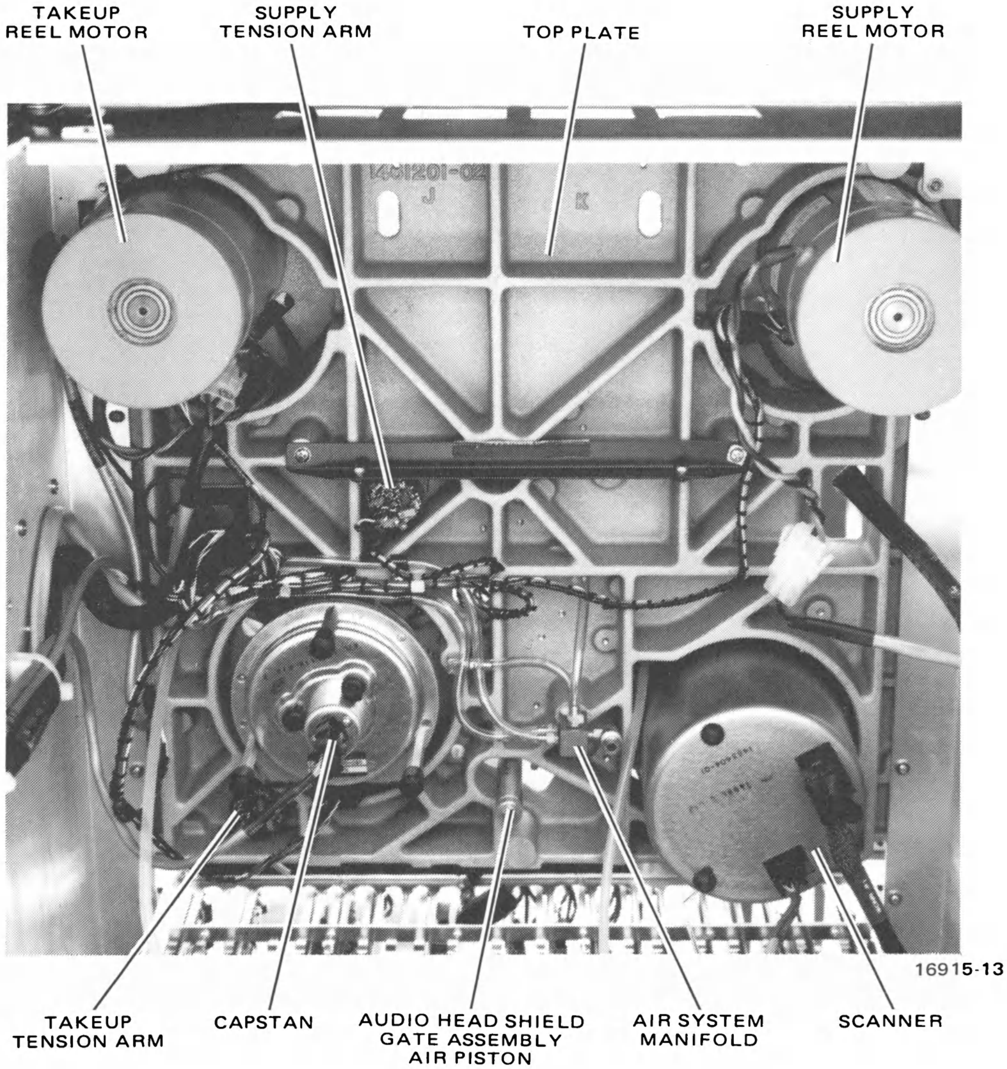


Figure 6-2. Transport System—Rear View

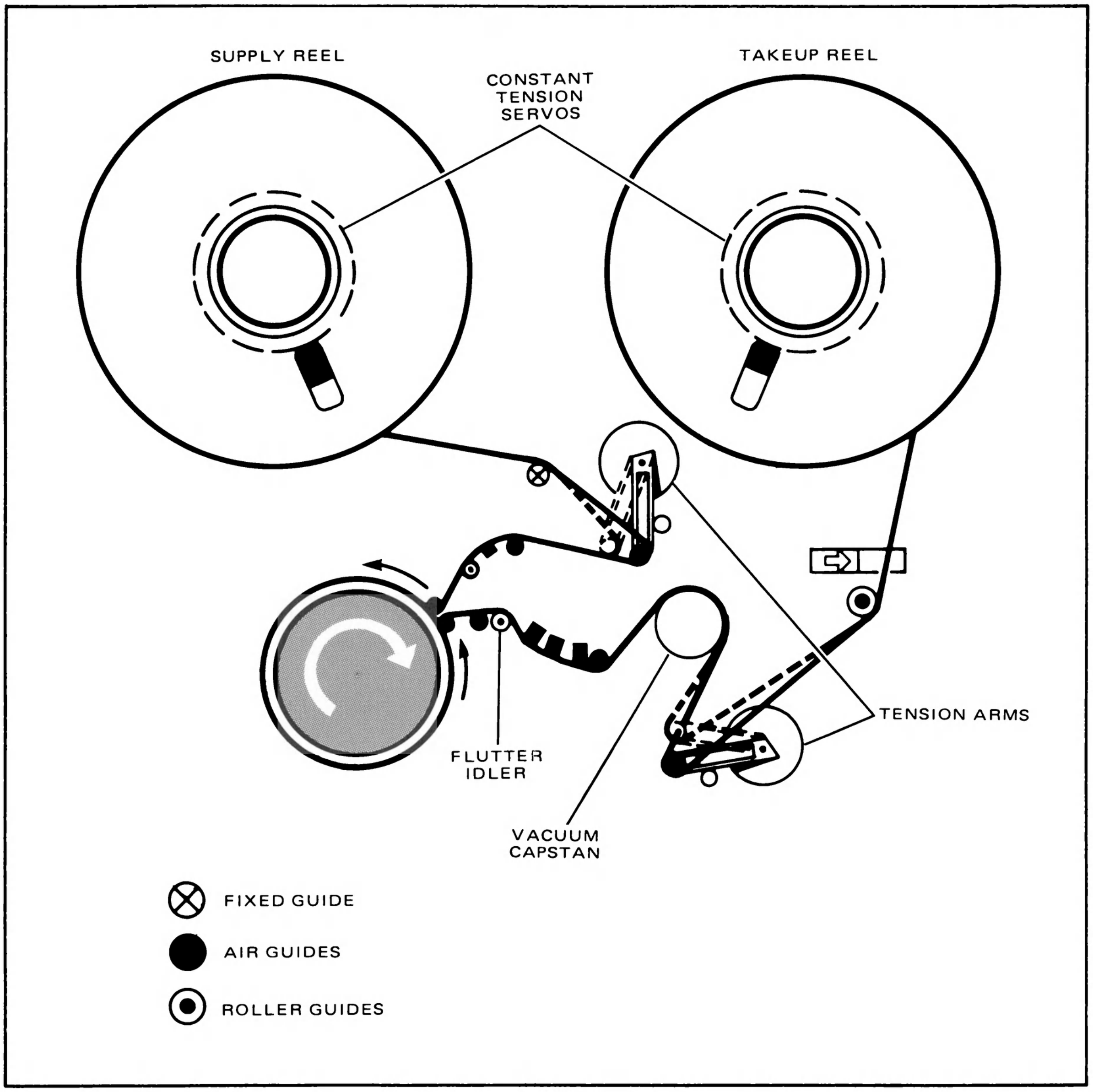


Figure 6-3. Tape Path in Transport System

6-4 Top Plate

The top plate is a ribbed aluminum alloy casting with precision-ground threaded bosses upon which transport subassemblies are mounted. Subassemblies, except for capstan and air system subassemblies, are removable from the front side of the top plate.

The top plate is secured to the main frame of the VPR-3 with four screws, which are set at the factory for tilt angle, and should not be removed. Top plate removal is not a standard service operation.

6-5 Protective Trim

Protective trim covers transport subassemblies, and has cutouts for protruding parts. Seven screws hold it in place. Older versions of the protective trim plate had a hinged trim cover with a latch; newer versions have a hinged cover with cylinders on each side. Protective hinged cover and protective trim are removed together from the top plate, as described in paragraph 6-27.

CAUTION

TO AVOID DAMAGE TO THE VIDEO HEAD, BEFORE REMOVING THE PROTECTIVE TRIM ROTATE SCANNER SO PLAY HEAD IS PROTECTED BY ONE OF THE TAPE GUIDES.

6-6 Reel Motors and Turntable Assemblies

Reversible dc motors drive supply and takeup reels. Tape reels are secured with hold-downs on the turntables, which are tightened or loosened with the knob. The transport can handle 14-inch, three-hour reels containing 9200 feet of tape to spot reels containing 15 to 20 seconds of tape. The servo system is designed to handle the preloaded weight of the reel hubs for both static and dynamic inertia values. Supply and takeup reel and turntable assemblies are similar. Figure 6-4 shows a view of the reel motor and turntable assembly.

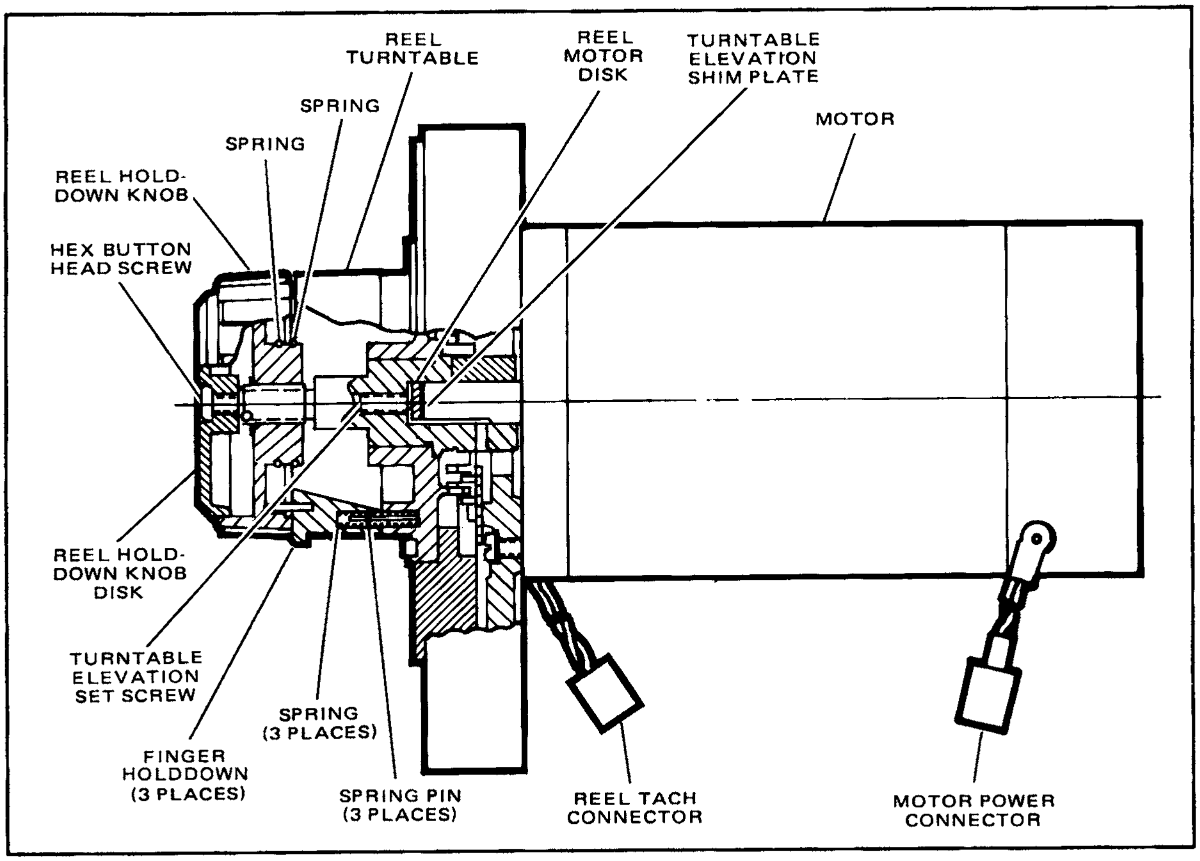


Figure 6-4. Reel Motor and Turntable Assembly

Note

Always secure reels firmly on turntable using reel hold-down knobs.

Takeup reel A wind or B wind direction is determined by jumper block position on the Tape Direction PWA. (See paragraph 6-16.) The procedure for changing from 2-hour reel size for rack-mount models to 3-hour reel size is covered in paragraph 6-29.

6-7 Air Guides

Seven air guides are used in the tape path, plus the vacuum capstan. See Section 9 for a general description of the air system. These air guides reduce friction, and provide fast gentle tape handling with predictable friction characteristics for all brands of tape. In each air guide, air is forced out of small holes that extend from the surface to an interior air chamber, forming a thin air film that cushions the tape from the guide surface. Location of the air guides and vacuum capstan is shown in Figure 6-3.

6-8 Supply and Takeup Tension Arm Assemblies

Tension arm assemblies operate to maintain proper tape tension off the supply reel and onto the takeup reel. An adjustable spring subassembly provides a uniform forward tension, while the air dashpot with variable pressure provides a dynamic balanced backward tension for the supply tension arm. Another air dashpot on the takeup tension arm acts as a damping system. An air guide on each tension arm minimizes tape friction. Figure 6-5 illustrates a side view of the supply tension arm assembly (takeup tension arm assembly is similar).

The tension arm assembly contains an LED and photopotentiometer, which form a circuit to detect tape direction based on tension-arm position. This sensing circuit is connected to the corresponding reel motor by way of reel servo electronics.

6-9 Video Erase Head Assembly

The video erase head assembly contains the video erase head, tape presence sensor, and tape guides, plus mounting support. It erases the video track (and sync track when present) on the tape, as directed by the control circuitry. The video erase head must be positioned correctly. The tape sensor detects whether tape is in the transport system. Figure 6-6 shows a side view of the video erase head assembly.

6-10 Scanner Assembly

Major scanner assembly components are a servo-controlled brushless printed circuit dc motor, a stationary lower drum, a rotating upper drum, and entrance and exit guides. Figure 6-7 shows the scanner assembly in the VPR-3, with an insert showing the scanner itself. Figure 6-8 shows the scanner assembly wiring schematic (partial).

The scanner has positions for six heads in accordance with Type C format specifications, and contains three active video heads (edit erase, record, and playback) spaced 120 degrees apart, and three dummy heads. When the sync

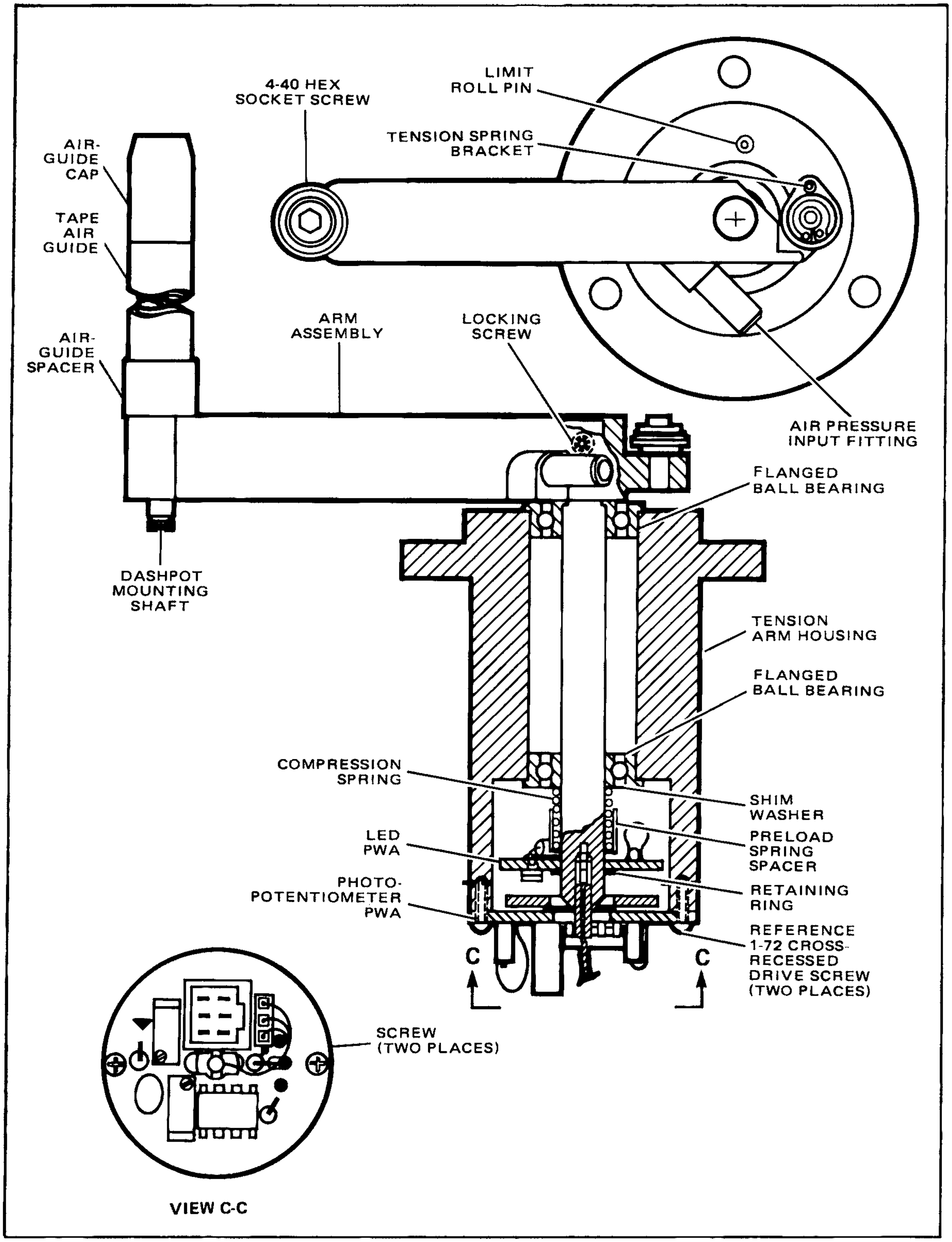


Figure 6-5. Tension Arm Assembly

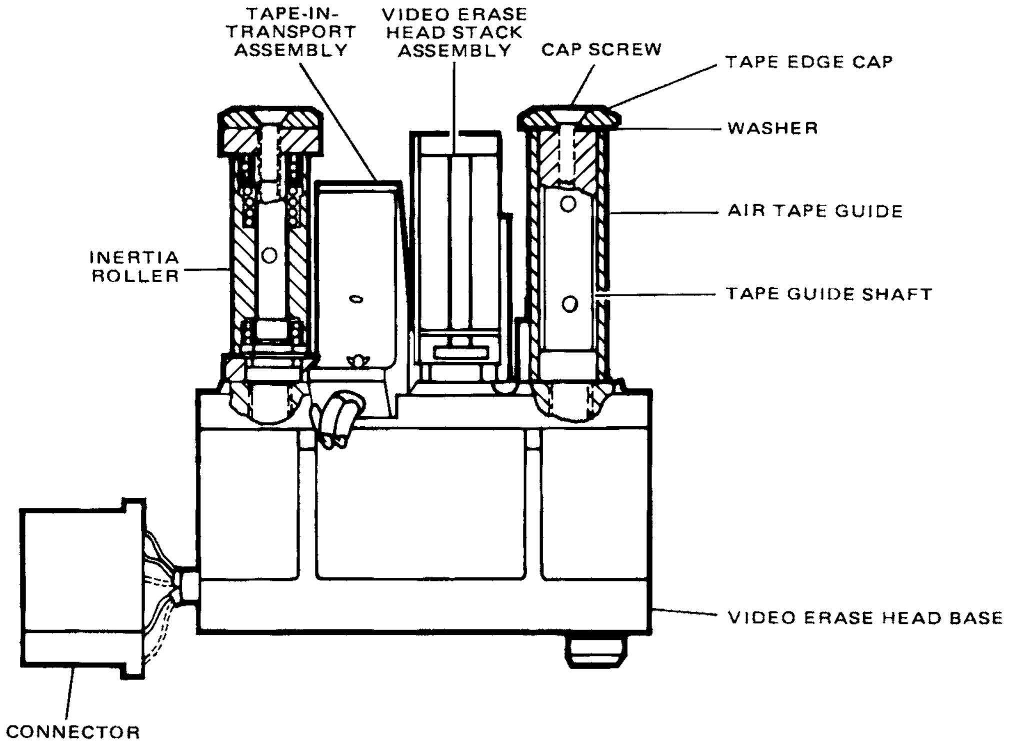


Figure 6-6. Video Erase Head Assembly

channel option is installed, dummy heads are replaced by sync channel erase, record, and playback heads. The video playback head is a special AST playback head. The scanner also contains rotary transformers to transfer signals to and from heads between rotary and stationary elements of the scanner assembly. Video head replacement is covered in paragraph 6-38.

The scanner contains two tach assemblies—the motor tach for commutating the motor, and the once-around tach for scanner phasing. These tach assemblies provide feedback to the Scanner/Capstan MDA in the power supply and to the Reel and Scanner Servo PWA (A14) for controlling the scanner motor. A notched lever on the lower drum is used for scanner phasing adjustment. The Edit Erase PWA is connected to the scanner assembly, and is used to control video edit erasing and sync edit erasing signals. Scanner removal and replacement operations are covered in paragraphs 6-37 through 6-43.

The record amplifier in the scanner assembly interfaces video/sync signals from the electronics bay to the scanner record heads through a rotary transformer assembly.

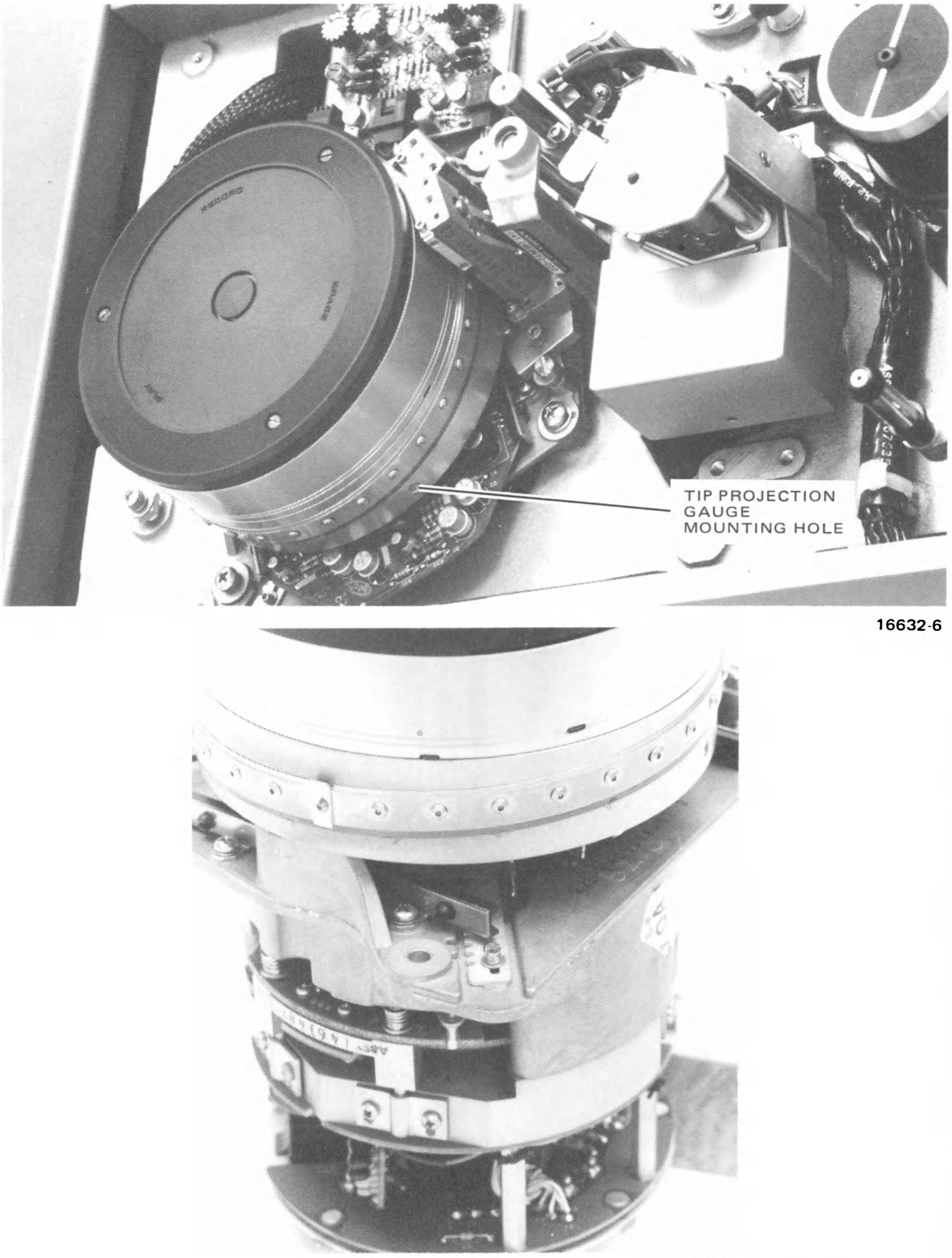


Figure 6-7. Scanner Assembly

The stationary lower drum has a guide band to direct tape around the scanner. Guide band position should not be changed. The upper drum contains the video heads, and has a black cover marked with head positions. Video heads can be changed without removing the scanner assembly from the transport. Figure 6-9 is a view of the scanner upper drum with cover removed, showing video heads and circuitry.

Entrance and exit guides are fixed on a mounting plate attached to the scanner assembly. Precise alignment of these guides is critical to achieving the correct helical track and dropout pattern for the video signals. Air enters the scanner assembly through a fitting in the scanner base, and passes through an air guide on each side. Two guide pins, one for the entrance tape guide and the other for the exit tape guide, are used to position tape. Adjusting screws are used to align guide pins. Refer to the interchange procedure (starting at paragraph 6-48) for more alignment information.

Note

> **Small covers for the entrance and exit tape guides must be removed before transport trim can be taken off.**

6-11 Scrape Flutter Idler Assembly

The flutter idler smooths tape motion, as seen in Figure 6-10. An air guide is incorporated into the assembly. Removal and disassembly are covered in paragraph 6-44.

6-12 Longitudinal Head Assembly

The longitudinal head assembly consists of three head stacks mounted on a base. The first stack consists of erase heads for each of the audio channels and a head for control track erase. The second stack has record/playback heads for each of the audio channels and another record/playback head for the control track. The third stack has heads for the control track and each audio channel confidence function. Figure 6-11 shows the longitudinal head assembly and head stacks. The head assembly also includes an air guide for tape movement.

A number of different audio head stacks are available for three-channel or four-channel audio systems. Head mounting is identical for all machines. Each head is secured to the base with a screw, and the adjustable head stack position can be changed with the use of another screw, for azimuth correction. No preamplifier electronics exist in the head assembly; all electronics are found in the electronics bay. Each head stack has a connector for wiring; care should be taken when removing or inserting leads to avoid bending connector pins.

Positioning of the base plate must be exact to maintain control track alignment. A set of gear teeth can be used to position the base; mark position before removal for approximate relocation point. If base plate has been moved, refer to the interchange procedure for alignment in paragraph 6-48.

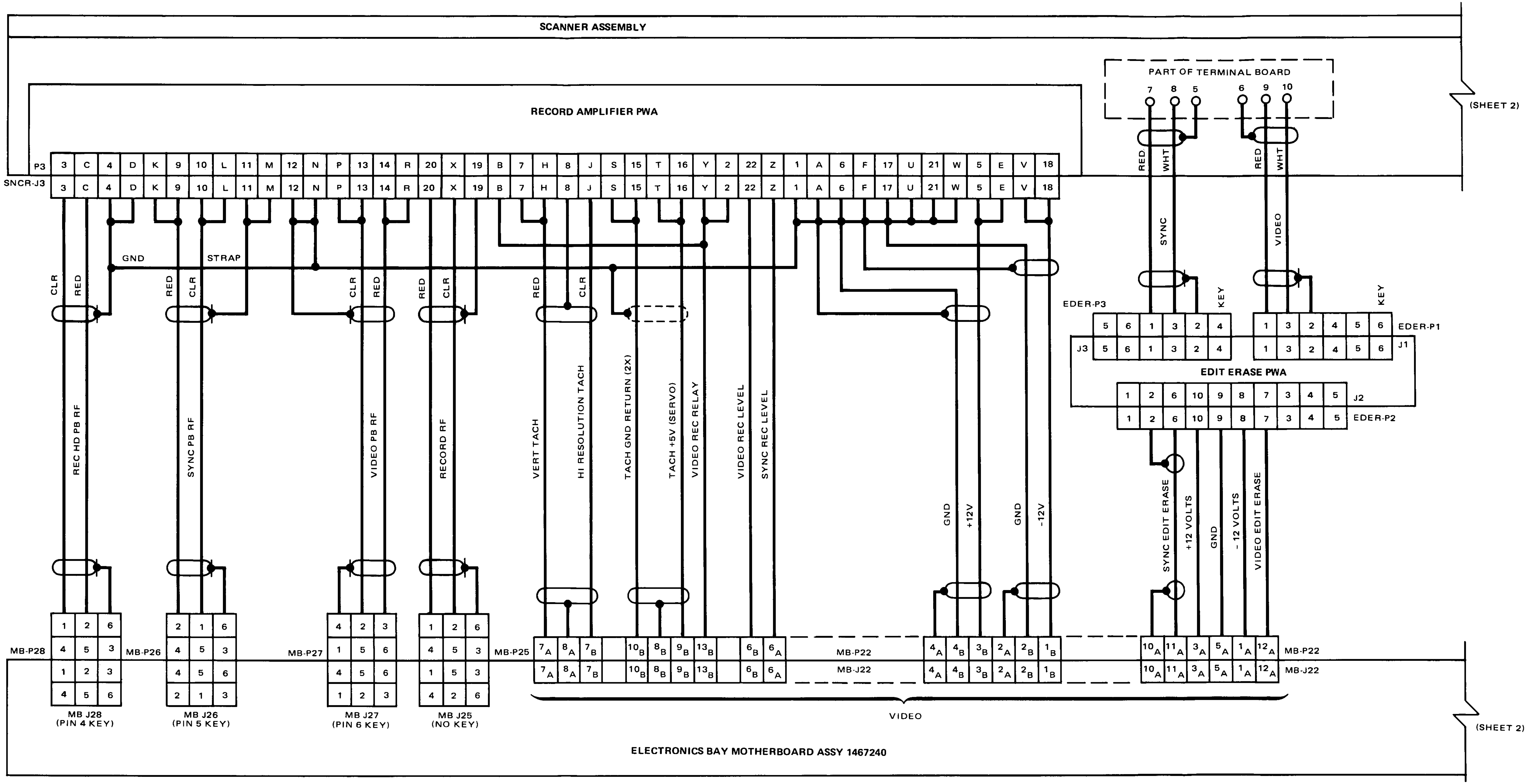


Figure 6-8.
Scanner Assembly Wiring Schematic
(Sheet 1 of 2)

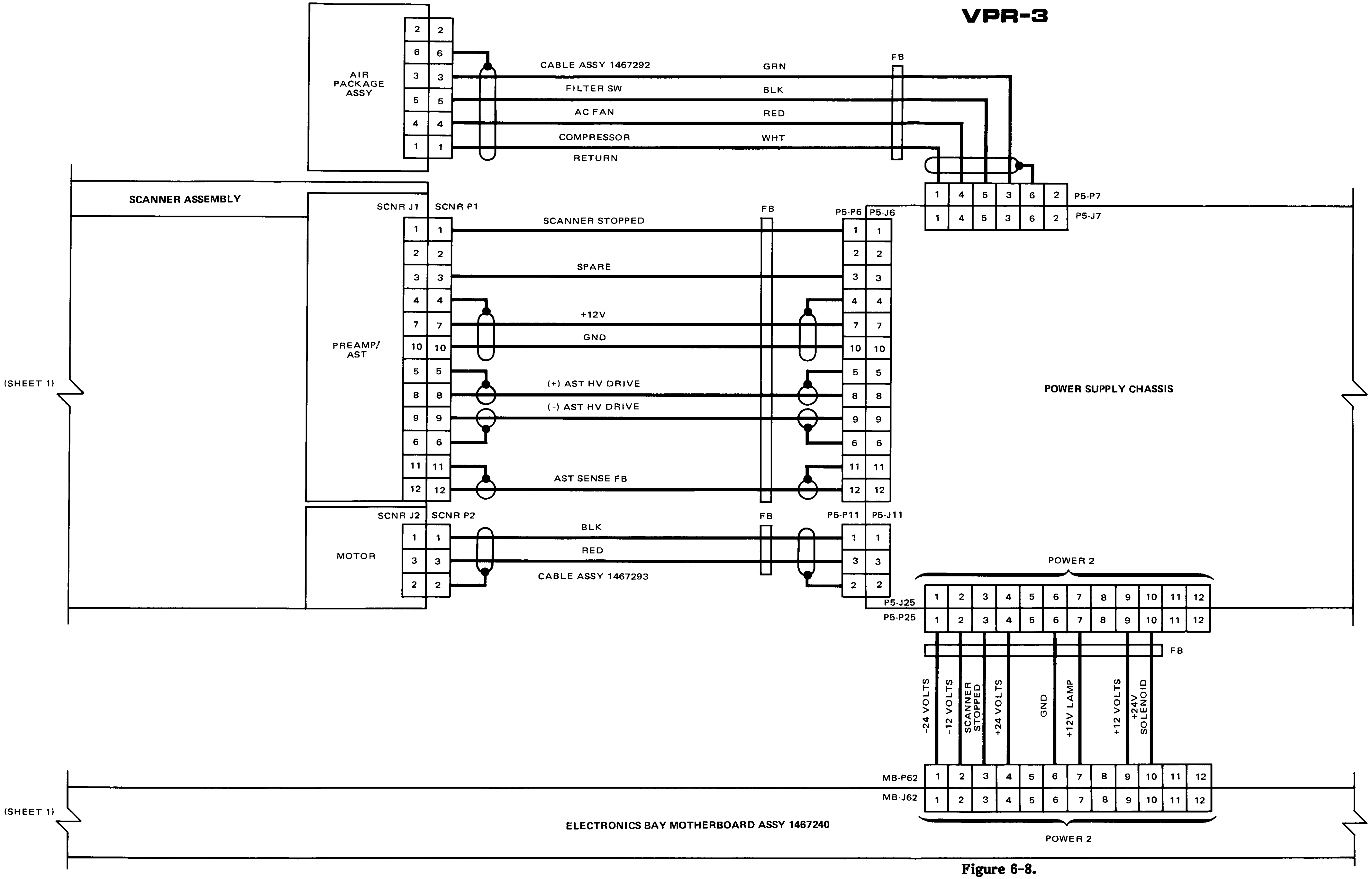


Figure 6-8.
Scanner Assembly Wiring Schematic
(Sheet 2 of 2)

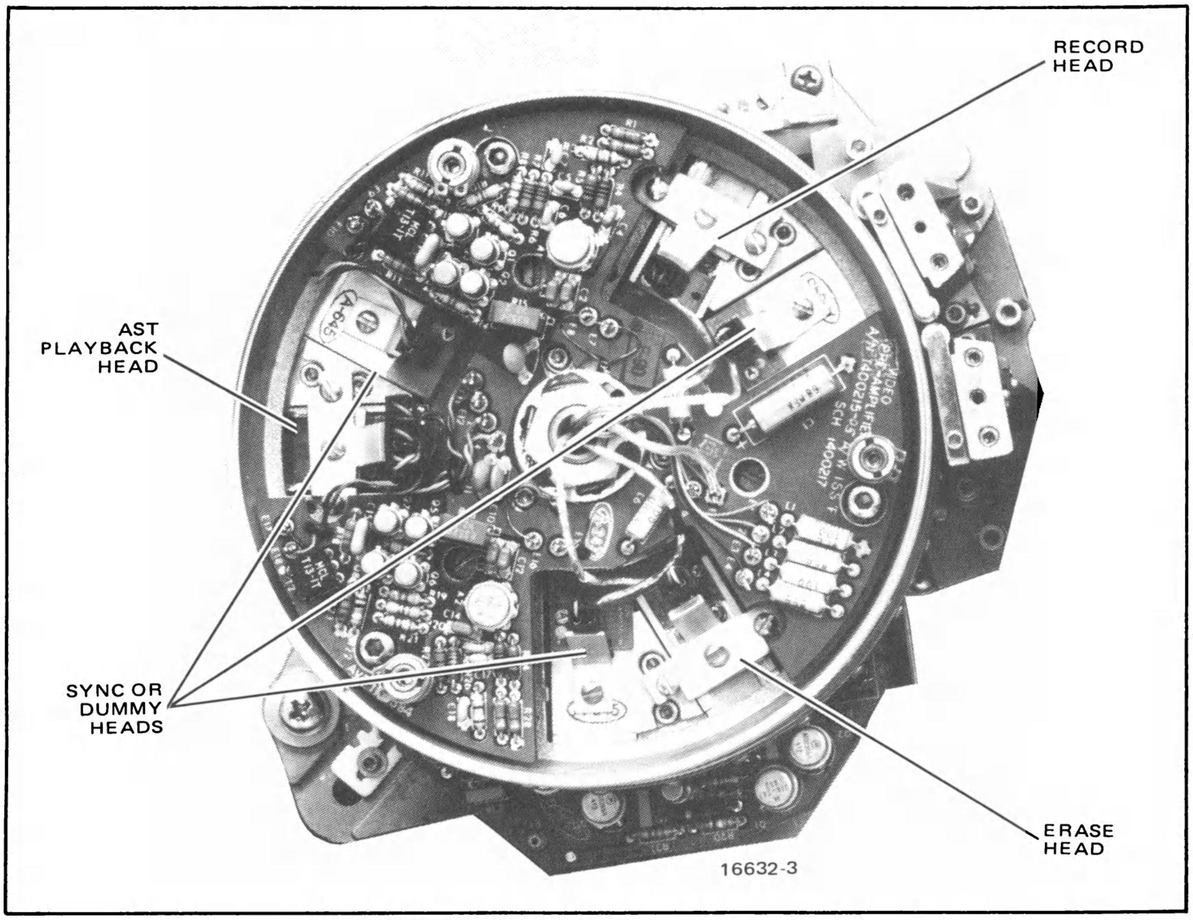


Figure 6-9. Scanner Upper Drum with Cover Removed

6-13 Shield Gate Assembly

A shield gate assembly shields the audio heads to minimize external noise. This assembly consists of a cover, shield, and gate, and a plunger system, as shown in Figure 6-12. In normal operation, the audio head shield gate is positioned by the plunger to cover the audio heads during recording and playback.

The shield gate assembly must be removed before the longitudinal head assembly is taken off the top plate. Removal and disassembly procedures are covered in paragraph 6-45.

6-14 Capstan Assembly

The capstan assembly uses a vacuum system to move tape through the VPR-3 transport system. Figure 6-13 shows the capstan assembly removed from the top plate. The capstan has a servo-controlled dc motor, an optical tachometer assembly, mounting plate, and a hub with air holes.

The vacuum capstan, which is directly driven by a servoed dc motor, controls tape speed. An optical tachometer supplies capstan speed information for the servo, and during record operations, the capstan determines track spacing. During playback, the capstan ensures accurate alignment of recorded tracks to the video head, with positional information being taken from the control track. Continuous capstan control of tape motion allows use of a coupling servo, which monitors both air guide tension arm subassemblies to regulate capstan acceleration in accordance with reel servo capabilities. As a result, the capstan optical tachometer can replace a separate tape timer tachometer assembly. The VPR-3 gives a selectable digital readout display of tape timer position.

The capstan motor receives power from the unregulated high-voltage power supply. The motor is controlled by a dc error signal developed on the Servo PWA, which compares capstan tach signals to a reference frequency. The error signal is sent to the MDA PWA, where it is processed through amplifiers and combined with a feedback signal. Two pairs of transistors are biased to supply control current for either direction. This control system is self-correcting for individual motor characteristics and power fluctuations.

The capstan hub has rows of air intake holes, with vacuum supplied by the air system manifold; these holes must be kept clean.

Capstan removal and replacement procedures are covered in paragraph 6-47.

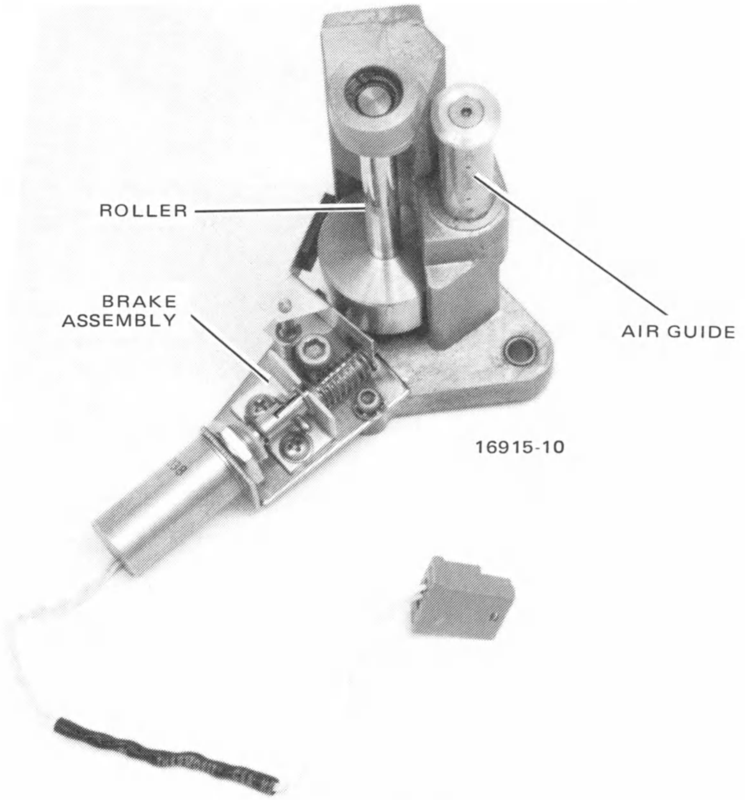


Figure 6-10. Scrape Flutter Idler Assembly

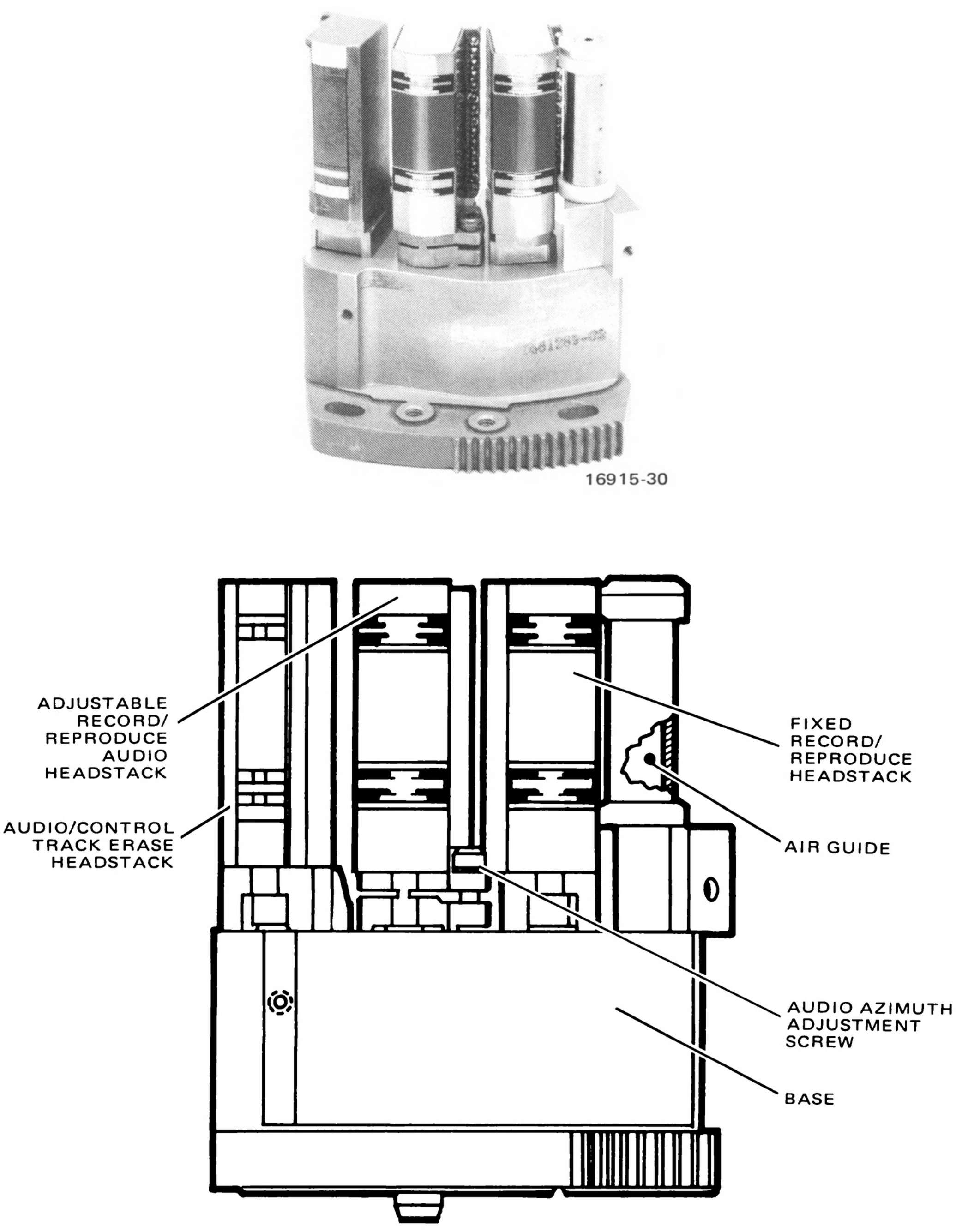

16915-30
ADJUSTABLE RECORD/ REPRODUCE AUDIO HEADSTACK
AUDIO/CONTROL TRACK ERASE HEADSTACK
FIXED RECORD/ REPRODUCE HEADSTACK
AIR GUIDE
AUDIO AZIMUTH ADJUSTMENT SCREW
BASE

Figure 6-11. Longitudinal Head Assembly

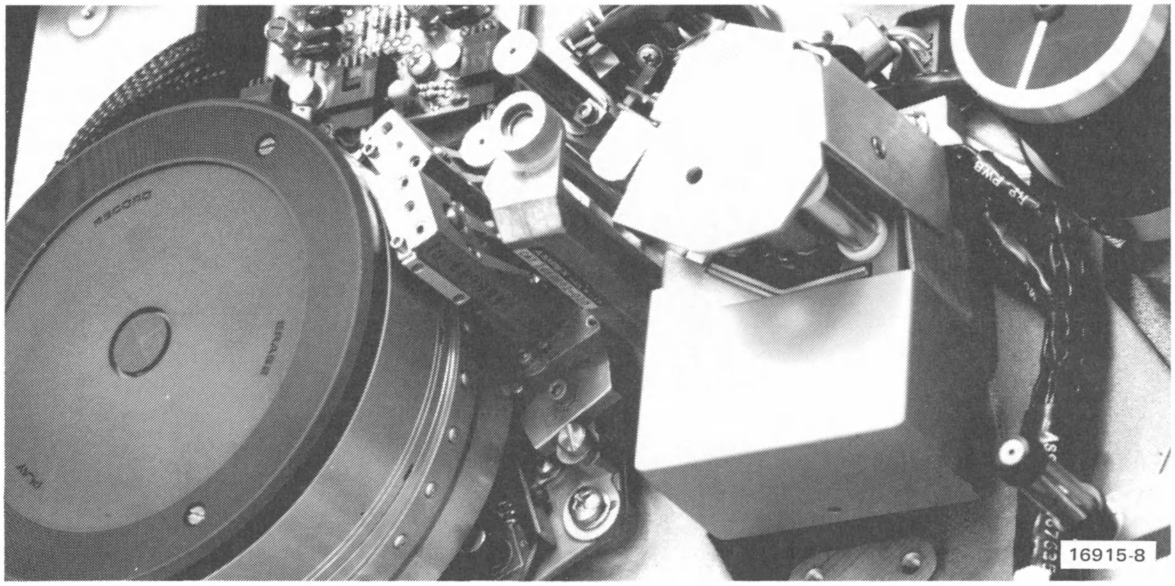


Figure 6-12. Audio Head Shield Gate Assembly

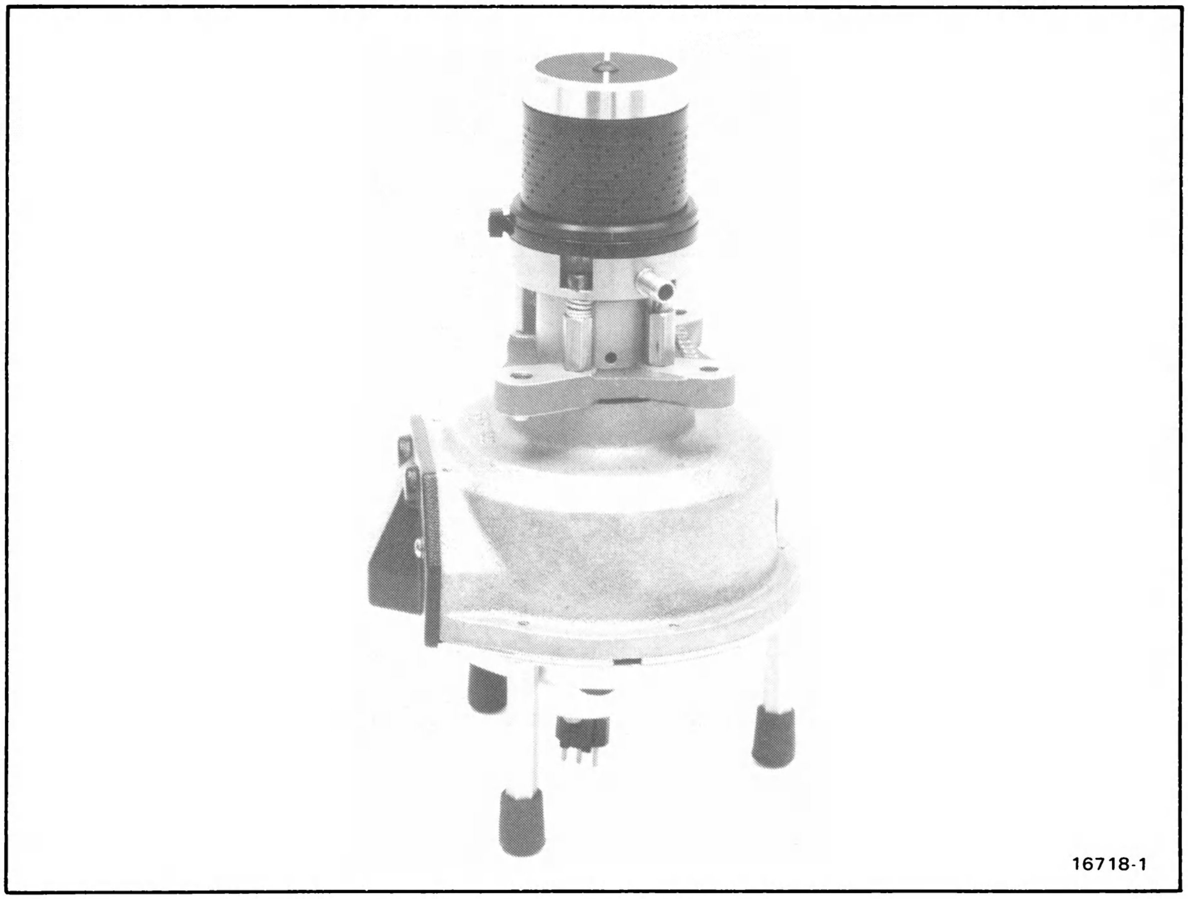


Figure 6-13. Capstan Assembly

6-15 Head Hour Meter

The head hour meter, mounted on the top plate below the takeup reel, records the number of hours (to tenths) that scanner heads are in contact with tensioned tape. The meter is mounted on a plate secured by two screws to the top plate, one of which also secures an air hose clamp. Meter readings can be used to estimate servicing and replacement requirements. Meter removal does not affect VPR-3 operation.

6-16 Tape Direction Switch

The tape direction switch (see Figure 6-1) consists of a small PWA with a jumper block. This switch determines direction of the tape reel (A wind is normal; B wind is alternate wind). Figure 6-14 shows the two switch positions and direction of tape takeup wind.

6-17 TRANSPORT SYSTEM CLEANING AND MAINTENANCE

The following procedures describe cleaning and maintenance procedures that should be used on the VPR-3 transport system.

6-18 General Cleaning Procedures

The VPR-3 transport area should be kept as clean as possible to avoid tape contamination, head clogging or damage, or air system clogging. When cleaning the VPR-3, first power-off the equipment and remove tape. Cover the operator control panel with a cloth or protective cover. Start dust removal and cleaning from the top of the machine, and work downward. Make sure cleaning solutions are appropriate for the area being cleaned, particularly solvents and strong cleaners. Table 6-1 lists cleaners that should be used for specific areas.

6-19 Head and Tape Path Cleaning

Oxide particles from magnetic tape tend to collect on components in the tape path. These oxide accumulations degrade recorder performance. Clean tape path components after every eight hours of operation, or more frequently depending upon operating environment and type and cleanliness of tape used. The operator should visually inspect scanner, guides, and capstan surfaces prior to every major record/playback session, and remove any oxide residue present on these surfaces using recommended cleaning agent.

CAUTION

RESTRICT USE OF CLEANING AGENTS TO ONLY THOSE PARTS TO BE CLEANED. EXCESS AMOUNTS CAN SPREAD TO OTHER PARTS SUCH AS PLASTICS AND HARM THEM, OR ATTACK CERTAIN BONDING AGENTS.

Unthread any tape which may still be on the machine. Locate entrance and exit air guides at the top of the scanner assembly, and check for oxide particles on the guides. If oxide particles are present, clean guides with a cotton-tipped swab moistened with Ampex Head Cleaner (Ampex Part No. 087-007) or xylene.

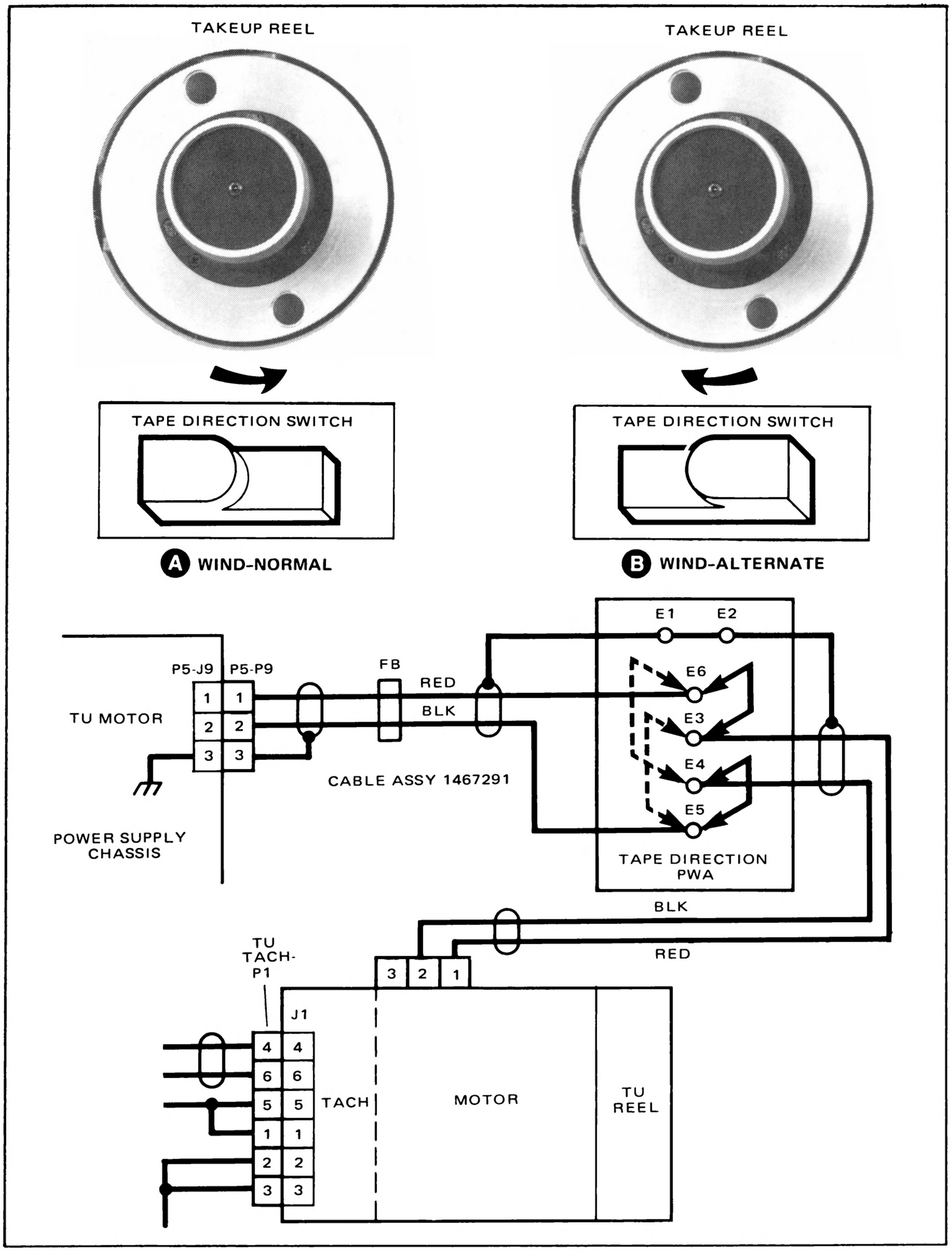


Figure 6-14. Tape Direction Switch

Table 6-1. Cleaning Solutions

Area	Solution
Painted sheet metal surfaces	Mild household cleanser
Plastic protective trim and trim panel	Mild household cleanser
Plastic scanner guide covers	Mild household cleanser or isopropyl alcohol
Video erase head	Ampex Head Cleaner
Longitudinal Head Assembly	Ampex Head Cleaner

Hold a lint-free wipe moistened with head cleaner on scanner surface near junction of the upper and lower scanner assembly sections, and apply light pressure.

CAUTION

DO NOT CLEAN HEADS WITH A VERTICAL MOTION AT RIGHT ANGLES TO THE HEAD, AS DAMAGE TO HEADS CAN OCCUR. DO NOT USE ALCOHOL TO CLEAN SCANNER SURFACE. ALCOHOL TENDS TO LEAVE A PERSISTENT RESIDUE THAT INCREASES FRICTION BETWEEN TAPE AND SCANNER.

Keeping lint-free wipe in position with one hand, rotate scanner assembly slowly clockwise two or three complete revolutions. Do not move the wipe; any in-and-out movement can damage a head. Transducers in the heads are made of a delicate ferrite material, and are bonded to the head assembly by epoxy cement.

Check scanner guide band for dust and oxide particles. It is important that this guide band be free of dust and dirt; tape must ride flush to the guide, or track straightness will be affected.

With a fresh lint-free wipe moistened lightly with an approved head cleaner, clean video erase head, audio and control track heads, and tape guides.

If capstan requires cleaning, use a linen cloth moistened lightly with alcohol. Be careful not to clog vacuum holes with lint from the cloth.

Clean tension arms, idler assembly, etc., as necessary with a soft lint-free cloth using cleaning fluid. Inspect air holes for clogging.

Care should be taken not to drip any head cleaning fluid onto operator control panel.

6-20 Cleaning Optical Devices

Optical devices on the VPR-3 seldom need cleaning, and should not be cleaned on a routine basis. However, if required, clean photosensitive devices as follows:

CAUTION

DO NOT USE ANY SOLVENTS, ALCOHOL, WINDOW CLEANER, OR CLEANER OTHER THAN WATER, ON ANY PHOTO-POTENTIOMETER, LED, OR ANY PHOTOSENSITIVE DEVICE. TO DO SO WILL CAUSE DAMAGE TO PLASTIC COVER. MAKE SURE POWER IS OFF AND DEVICE IS COOL.

Clean LED and photopotentiometer of any photosensitive device with a dry cotton-tipped applicator or, if necessary, an applicator moistened only with water.

6-21 Cleaning Scanner Slip-Rings and Brushes

To ensure reliable performance, scanner slip rings and slip-ring brushes require periodic inspection and cleaning. Recommended inspection interval is 500 hours of operation. Clean slip rings and slip-ring brushes with compressed air, or, if necessary, with freon TF. To clean slip rings and brushes, proceed as follows:

CAUTION

DO NOT USE HEAD CLEANER, FLUX-REMOVER SOLVENTS, OR ISO-ALCHOHOL. WHEN HANDLING SCANNER ASSEMBLY, BE CAREFUL NOT TO TOUCH PROTRUDING HEAD TIPS.

STEP 1 Remove scanner assembly from transport as described in paragraph 6-38.

STEP 2 Install scanner service leg set assembly on scanner and rest inverted scanner on work bench.

STEP 3 With scanner rear facing upward, remove two screws securing motor cover to scanner assembly, and remove cover. Remove plate containing power transistors. See paragraph ~~6-40~~, steps 3 through 5.
6-39

STEP 4 Use compressed air to clean slip rings and brushes. Turn drum slowly so that brushes wipe slip rings. A cotton-tipped swab can be used to wipe slip rings if care is used to ensure that cotton filaments are not left behind to foul brushes. Permit slip rings and brushes to dry thoroughly before reinstalling plate and motor cover.

STEP 5 Reinstall plate and motor cover removed in step 3.

STEP 6 Separate leg set from scanner, and reinstall scanner assembly in transport.

6-22 Air Guide Cleaning

If necessary, air guides can be removed and cleaned using the following procedure:

STEP 1 Remove air guide. This may involve removal of entire assembly. Refer to pertinent disassembly procedure (see paragraphs 6-26 through 6-53). Some air guides are secured with loctite adhesive, and cannot easily be removed, requiring modification of the suggested cleaning procedure that follows.

STEP 2 Use one tablespoon of surgical detergent such as Alkonox in one-half gallon hot water (140 to 160 degrees Fahrenheit). Be sure detergent is completely dissolved. If necessary, a readily available laundry detergent containing borax can be used.

STEP 3 Soak air guide assembly or air guides for at least 5 minutes while agitating the solution.

STEP 4 Rinse in running hot water until all detergent is gone.

STEP 5 Immerse guides in hot water in an ultrasonic cleaner for at least 3 minutes.

STEP 6 Remove and drain the water. Fill a jar with isopropyl alcohol and let guides stand in it for a few minutes to dilute water.

STEP 7 Remove parts and dry with clean (filtered) dry air if possible.

Note

Do not immerse guides in acetone or alcohol unless the water/detergent cleaning cycle was performed. Do not immerse scanner air guides with plastic tubes attached; do not immerse entire scanner guide block assembly in acetone.

Guide pins with white epoxy adhesive on the tubing can be cleaned directly with alcohol and an ultrasonic cleaner. Do not use acetone or MEK for cleaning; these solvents will attack tubing and adhesive. Use only standard isopropyl alcohol.

6-23 Demagnetizing

Heads and other tape path components should be demagnetized at regular operating intervals.

CAUTION

DO NOT REMOVE HEAD ASSEMBLIES OR PRINTED WIRING ASSEMBLIES (PWA) WITH POWER ON. TO DO SO WILL CAUSE HEAD TO BECOME MAGNETIZED.

Heads and other components in the tape path can acquire permanent magnetization that degrades signal-to-noise ratio, increases distortion, and partially erases high frequencies on recorded tapes. Use an Ampex head demagnetizer or equivalent to demagnetize components in the tape path.

CAUTION

REMOVE RECORDED TAPE FROM VICINITY OF THE DEMAGNETIZER TO PREVENT ACCIDENTAL TAPE ERASURE.

Proceed as follows:

STEP 1 Turn equipment power off, and remove any recorded tape that is near transport system.

STEP 2 Ensure that metal demagnetizer tips are covered completely. If necessary, recover metal tips with electrical tape.

STEP 3 With demagnetizer at least three feet away from head assembly, connect demagnetizer to an appropriate ac power source.

STEP 4 Slowly move demagnetizer toward one head stack and lightly place demagnetizer tips to the base of the stack, straddling the head gap.

STEP 5 Using a slow, even motion, move demagnetizer tips up and down entire face of stack several times. Then slowly withdraw demagnetizer. Make certain that demagnetizer metallic tip *never* touches head stack surface.

STEP 6 Repeat steps 4 and 5 for each head stack.

STEP 7 To demagnetize video heads, rotate scanner to expose head. Gently move demagnetizer tips over video head. Demagnetizer metallic tip should never touch head surface. Repeat for all video heads.

STEP 8 Demagnetize all surfaces in tape path, such as roller bearings and air guides. Using a slow, even motion, move demagnetizer tips up and down entire surface touched by tape. It may be necessary to use a larger demagnetizer for the vacuum capstan.

STEP 9 Slowly move demagnetizer at least three feet away from head assembly, and then unplug demagnetizer.

6-24 Lubrication

All critical wear surfaces incorporate prelubricated ball bearings, permanently lubricated sleeve bearings, impregnated lubricants, or lubricant-filled materials.

CAUTION

LUBRICATE NO PART OF THIS MACHINE EXCEPT WHEN INSTRUCTED TO DO SO IN MAINTENANCE PROCEDURES, AND WHEN SO INSTRUCTED, USE ONLY SPECIFIED LUBRICATING MATERIAL.

6-25 TRANSPORT SYSTEM AIR FLOW AND TAPE TENSION MEASUREMENTS

The tape transport system on the VPR-3 is designed to provide optimum performance when air flows and tape tensions are correctly adjusted. While individual machines may vary slightly from the nominal values listed below, excess variation can affect performance. Adjustment procedures are detailed in the interchange procedure (see paragraph 6-48).

Air flow measurements are displayed by the VPR-3 air system; gauges are accessed through the rear panel, with a placard identifying the gauges and settings. Tape tension measurements referred to in this section are for a fixed pin tentelometer gauge; if a rotating pin tentelometer gauge is used, values should be reduced by approximately 0.5 oz. All measurements should be made using a sample of Ampex 196 video tape; other types of tape can yield different values.

Air flows are as follows:

- Scanner entrance and exit guides—approximately 7.5 psi at 1.00 to 1.25 SCFH.
- Tension arm guides—approximately 5.0 psi.
- Capstan vacuum—approximately 70 inches.

Tape tensions (as shown in Figure 6-15) are as follows:

A. Between supply tension arm and longitudinal erase head—approximately 6.0 oz.
B. Between longitudinal erase head and scanner entrance guide—approximately 6.5 oz.
C. Between scanner exit guide and flutter idler assembly—approximately 8.0 oz.
D. Between longitudinal audio head assembly and vacuum capstan—less than 9.0 oz.
E. Between vacuum capstan and takeup tension arm—approximately 7.0 oz.
F. Between takeup tension arm and takeup reel—approximately 6.5 oz.

The measurement procedure is performed with the VPR-3 threaded with a sample reel of Ampex 196 tape, and the machine in the normal playback mode, as follows:

STEP 1 Check transport air guide pressure on air system gauges (accessed through rear panel on VTR). Nominal value should be approximately 5 psi.

STEP 2 Check scanner guide air pressure. Nominal value should be approximately 7.5 psi, with a flow rate of 1.00 to 1.25 SCFH.

STEP 3 Check capstan vacuum. Nominal value should be 70 inches of vacuum.

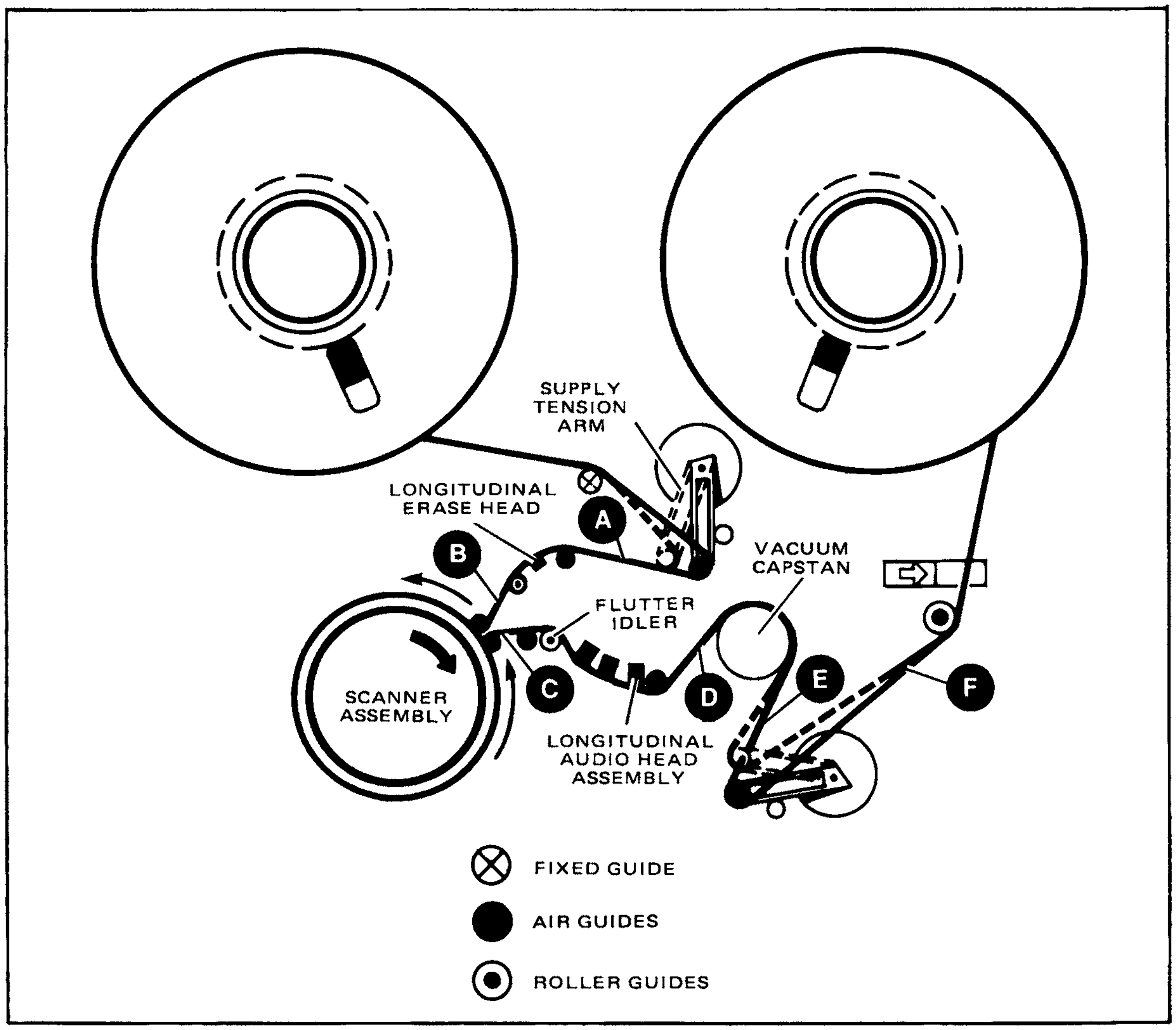


Figure 6-15. Transport System Tape Tension Measurements

STEP 4 Check tape tension at point A in Figure 6-15—nominal value should be approximately 6.0 oz. (±0.25 oz.).

STEP 5 Check tape tension at point B in Figure 6-15—nominal value should be 6.5 oz. (±0.25 oz.).

STEP 6 Check tape tension at point C in Figure 6-15. Tension buildup around scanner should not exceed 1.5 oz. (difference between measurements at point B and point C).

STEP 7 Check tape tension at point D in Figure 6-15—nominal value should be less than 9.0 oz.

STEP 8 Check tape tension at point E in Figure 6-15—nominal value should be approximately 7.0 oz. (±0.25 oz.).

STEP 9 Check tape tension at point F in Figure 6-15—nominal value should be approximately 6.5 oz. (±0.25 oz.).

STEP 10 Check capstan current—nominal value shown on the operator display panel on the front of the VPR-3 should be less than 0.9 amps. To view display, from the HOME menu, press **diag** soft key, then press **servo** soft key. The capstan current is displayed above the cap soft key. (Note: The warning **CAPSTAN CURRENT HIGH** is displayed if capstan current exceeds 1.2 amps.)

STEP 11 Press VAR PLAY switch to enter variable play operation. Turn transport control knob fully counterclockwise to set tape speed at reverse times normal play speed. Check capstan current value. Turn transport control knob to 1X forward speed (one detent clockwise past stop position). Check capstan current value displayed. Nominal capstan current values should be equal but of opposite signs (i.e., -0.8 and 0.8 amps).

STEP 12 If capstan current is too high, check air flow and pressure. Also check for rf envelope distortion around dropout area (see paragraph 6-48).

6-26 TRANSPORT SYSTEM REMOVAL, DISASSEMBLY, AND REPLACEMENT PROCEDURES

The following paragraphs describe removal, disassembly, and replacement procedures for transport system components. Alignment procedures are noted or referred to as necessary, and the interchange procedure described in paragraph 6-48 may be required after certain items have been removed.

Power off equipment and remove tape before performing service operations. Observe safety precautions to avoid electrical shock when it is necessary to apply power during a service operation. Extreme care should be taken to avoid electrical shorting.

We suggest that a cloth or paper cover be placed over the card cage before removing parts from transport area. Parts such as screws or washers which fall into the card cage can be difficult to recover and can damage the electronics.

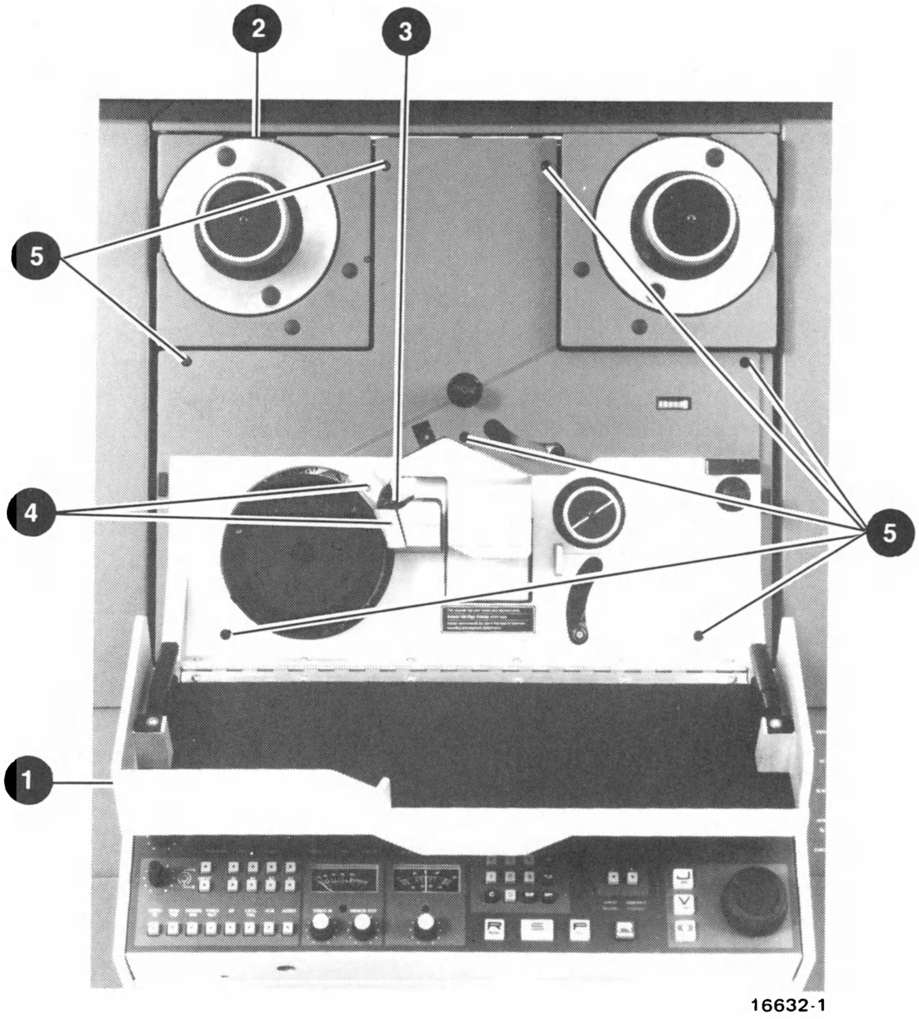
6-27 Trim Plate and Trim Cover Removal and Replacement

Trim plate (Assy No. 1467390) and trim cover (Assy No. 1467391) are removed together. Older VPR-3 versions have a different style trim assembly, with applicable differences noted. Refer to Figure 6-16 for details.

STEP 1 Open tape path trim cover.

STEP 2 Unthread tape and remove both tape reels.

STEP 3 Move scanner so play head is positioned under scanner tape guides for protection.



① LOWER TRIM COVER

② REMOVE TAPE REELS

③ POSITION PLAY HEAD UNDER SCANNER GUIDES

④ REMOVE SCREWS AND SCANNER GUIDE COVERS

⑤ REMOVE SCREWS

Figure 6-16. Protective Trim Removal

STEP 4 Remove two 4-40 hex socket button cap screws holding the plastic covers for scanner entrance and exit tape guides, and remove covers.

STEP 5 Remove the seven 8-32 panhead cross-recessed screws securing trim plate to top plate.

STEP 6 Lift trim plate off, with trim cover attached.

STEP 7 To separate trim plate and trim cover, turn trim panel over and remove 8-32 cap socket head screw, which secures the two cylinders, from recessed hole on each side of trim plate. (Note: Older versions do not have two cylinders.)

STEP 8 Remove six 8-32 buttonhead cap screws from hinge on trim plate, along with nylon washers. (Note: Older versions have two short hinges secured by two screws each in place of one long hinge strip.)

STEP 9 Replace cylinders with new units if required. Cylinders contain no replaceable parts, and should not be disassembled.

WARNING

DO NOT ATTEMPT TO DISASSEMBLE CYLINDERS—THEY ARE PRESSURIZED SEALED UNITS.

STEP 10 To replace trim cover, reverse order of steps. Be sure to return "O" rings (if present) to their seatings in the top plate before installing trim panel.

6-28 Reel Motor Removal

The following procedure is used for both takeup reel motor and supply reel motor assemblies, with a spacer representing the main difference between the two assemblies. The reel motor is removed with the turntable, turntable flywheel, and mounting base plate attached.

STEP 1 Unthread tape and remove reels.

STEP 2 Remove two black plastic caps from reel motor turntable, and two black plastic caps from motor mount plate. See Figure 6-17 (A).

STEP 3 Rotate turntable as shown in Figure 6-17 (B) to expose screws, and remove two 10-32 panhead cross-recessed screws.

STEP 4 Remove two 10-32 panhead cross-recessed screws from motor mount plate.

STEP 5 Gently lift reel motor assembly out of top plate recess, and disconnect two wiring harness connectors on back of motor. See Figure 6-17 (C).

STEP 6 To replace motor, reverse steps. Position motor locating pins first, then insert screws. Insert plastic caps back in correct positions; pairs are different sizes.

6-29 Reel Motor Mount Plate Position Change

Figure 6-18 shows the two reel mounting positions. To change positions, proceed as follows:

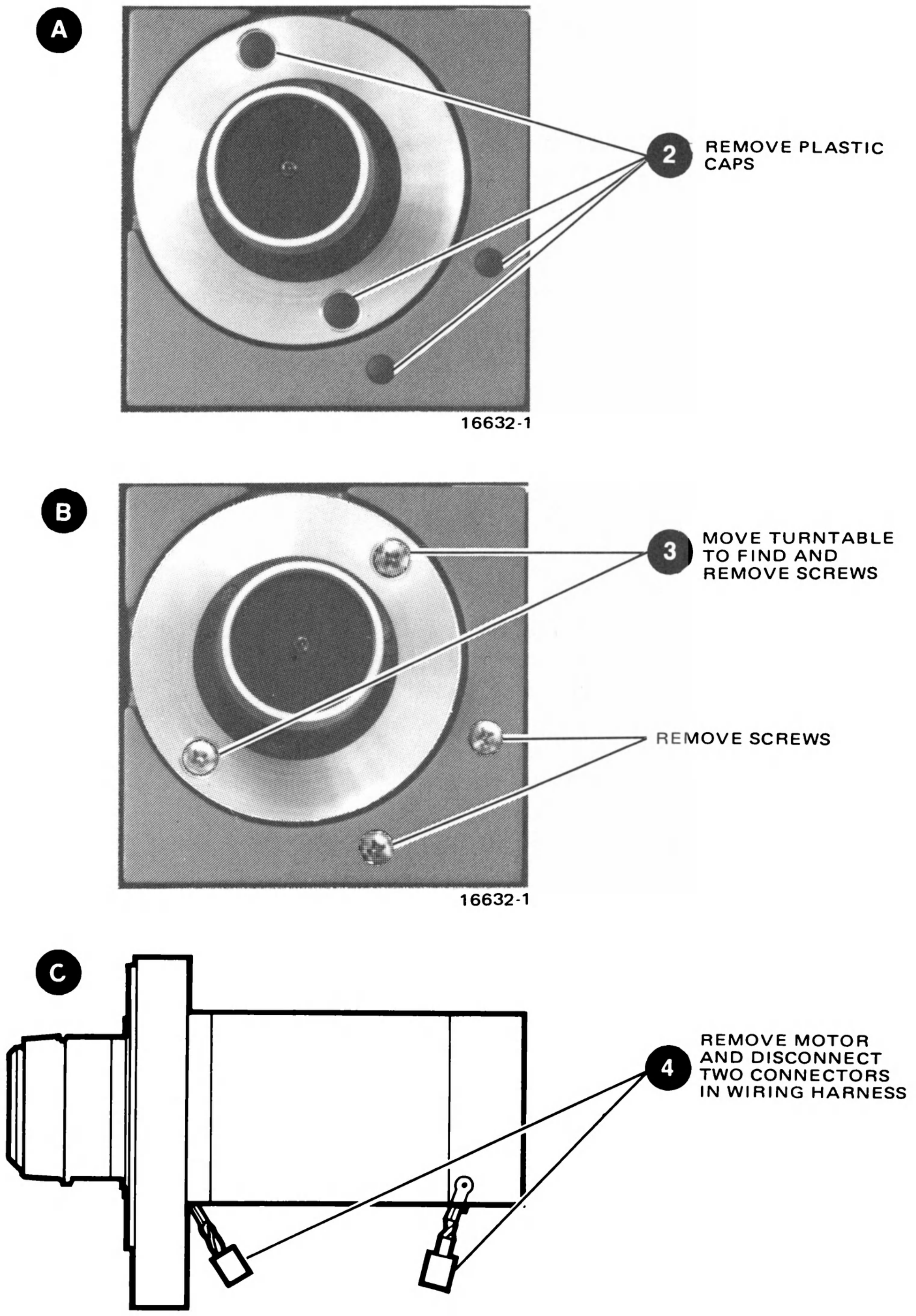

A
2
REMOVE PLASTIC CAPS
16632-1
B
3
MOVE TURNTABLE TO FIND AND REMOVE SCREWS
REMOVE SCREWS
16632-1
C
4
REMOVE MOTOR AND DISCONNECT TWO CONNECTORS IN WIRING HARNESS

Figure 6-17. Reel Motor and Turntable Removal

STEP 1 Remove tape reels.

STEP 2 Remove reel assembly, as detailed in paragraph 6-28.

STEP 3 Reposition motor mount plate in new position, using two locator pins.

STEP 4 Replace screws and caps removed in step 2.

STEP 5 Repeat procedure for other reel assembly.

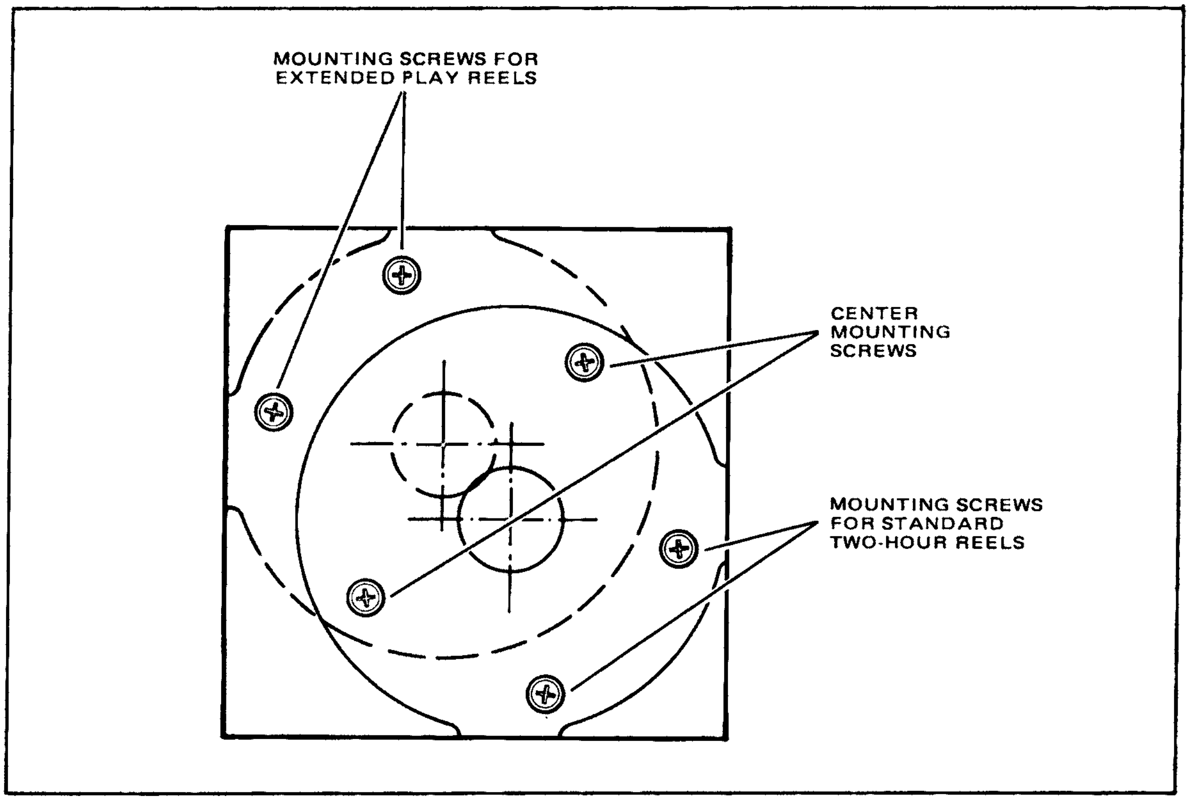

MOUNTING SCREWS FOR EXTENDED PLAY REELS
CENTER MOUNTING SCREWS
MOUNTING SCREWS FOR STANDARD TWO-HOUR REELS

Figure 6-18. Reel Motor Mounting Positions

6-30 Reel Motor Replacement

Reel motor replacement requires removal of reel motor assembly from top plate, and separation of turntable from motor. Component replacement can be performed during disassembly. Proceed as follows:

CAUTION

THIS PROCEDURE REQUIRES A DIAL VERNIER CALIPER WITH ACCURACY OF AT LEAST 1 MIL, OR A MICROMETER WITH A 1.5-IN. THROAT, WITH MINIMUM ACCURACY TO 1 MIL.

STEP 1 Remove reel motor assembly from transport as described in paragraph 6-28.

STEP 2 Remove 10-32 buttonhead hex socket screw securing retainer to knob, remove retainer (circular plate). See details in Figure 6-19.

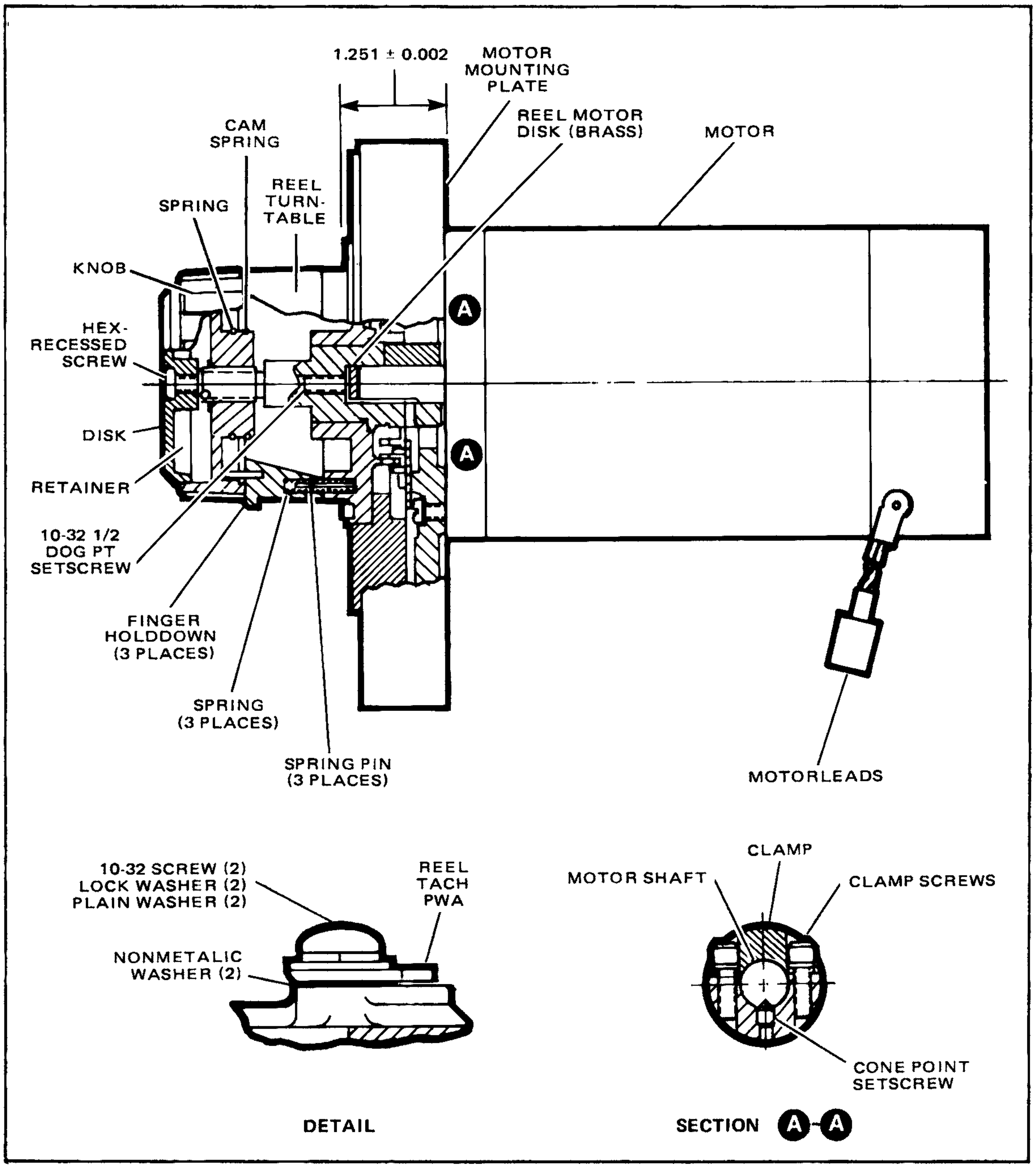


Figure 6-19. Reel Motor Replacement

STEP 3 Loosen the two 10-32 clamp screws and the 10-32 setscrew securing turntable assembly to motor shaft. (Note: Do not remove setscrew.) Access to shaft is provided by a notch in motor mounting plate. See Section A-A in Figure 6-19.

STEP 4 Pull turntable assembly straight up to remove from motor shaft. If turntable assembly is not easily removed, force off shaft by turning turntable elevation adjustment setscrew clockwise. Be sure not to lose any springs or other hardware. Access to elevation setscrew is through hole vacated by retainer screw removed in step 2. Use a 3-32 hex-drive wrench to turn screw clockwise to raise turntable. After removal, turn setscrew counterclockwise approximately an equal amount of turns, or until stop is reached. When turntable assembly is removed, be sure to save small loose brass reel motor disk on the end of the motor shaft.

CAUTION

IF ELEVATION ADJUSTMENT SETSCREW SHOULD COME OUT OF TURNTABLE, IT MUST BE REINSTALLED FROM BOTTOM OF TURNTABLE. IT WILL JAM IF INSTALLED FROM THE TOP.

STEP 5 Figure 6-20 shows a cutaway view of turntable and motor mount plate. Four 10-32 cross-recessed screws and hardware secure reel motor to motor mount plate. Two of these screws also secure the Reel Tach Processor PWA to motor mounting plate. Remove four screws and hardware, and separate motor from mounting plate. See detail in Figure 6-19.

Attach new motor to motor mounting plate as follows:

STEP 6 Note orientation of motor leads with respect to motor mounting plate (Figure 6-19). Loosely install the two 10-32 screws, plain washers, and lock washers shown on left-hand side of Figure 6-19.

STEP 7 Refer to detail in Figure 6-19, and install parts in sequence as follows: two nonmetallic washers, Reel Tachometer PWA, two plain washers, two lock washers, and two 10-32 screws (install loosely).

Before tightening PWA-securing screws, set distance between motor shaft edge and center point of the two optical coupler slots to 0.75 in. (19.1 mm). See Detail A in Figure 6-20.

STEP 8 Ensure that plain washers are not contacting traces on PWA, and then torque the four screws installed in steps 6 and 7 to 13.0 in/lb. (1.46 N/m).

STEP 9 Place brass disk removed in step 4 on top of motor shaft.

STEP 10 See Section A-A in Figure 6-19. Install turntable assembly on motor shaft as follows:

a. Position motor shaft so that V-groove in shaft is visible through notch in motor mounting plate.

b. Position turntable assembly so that cone point setscrew slides into motor shaft V-groove.

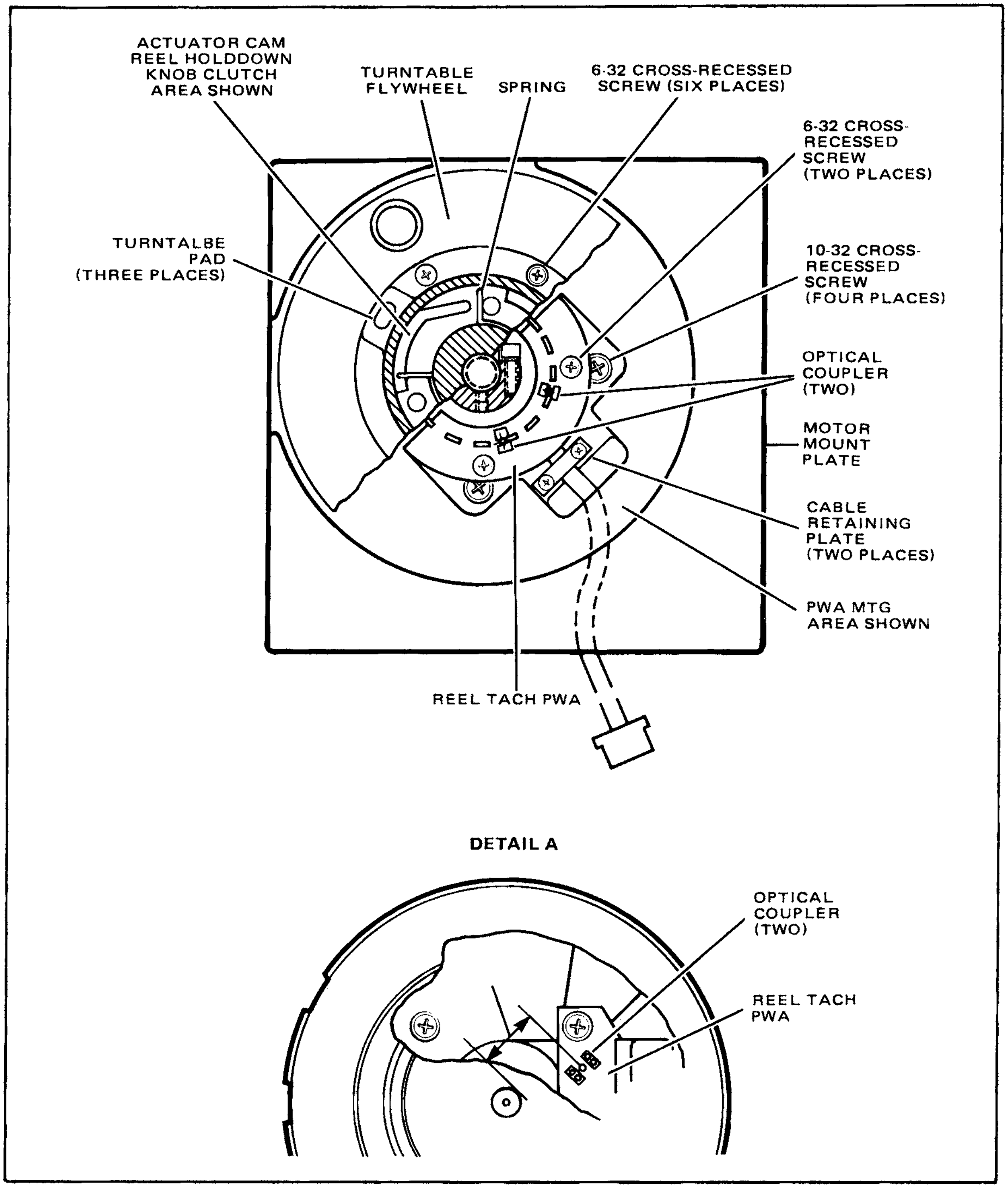

ACTUATOR CAM REEL HOLDDOWN KNOB CLUTCH AREA SHOWN
TURNTABLE FLYWHEEL
SPRING
6-32 CROSS-RECESSED SCREW (SIX PLACES)
6-32 CROSS-RECESSED SCREW (TWO PLACES)
TURNTALBE PAD (THREE PLACES)
10-32 CROSS-RECESSED SCREW (FOUR PLACES)
OPTICAL COUPLER (TWO)
MOTOR MOUNT PLATE
CABLE RETAINING PLATE (TWO PLACES)
PWA MTG AREA SHOWN
REEL TACH PWA
DETAIL A
OPTICAL COUPLER (TWO)
REEL TACH PWA

Figure 6-20. Reel Motor Assembly (with Turntable) Components

STEP 11 Before tightening turntable assembly, set turntable height to 1.251 in. (31.78 mm) as follows:

a. Locate each of the three raised areas on the turntable assembly that support turntable pads. See Figure 6-21.

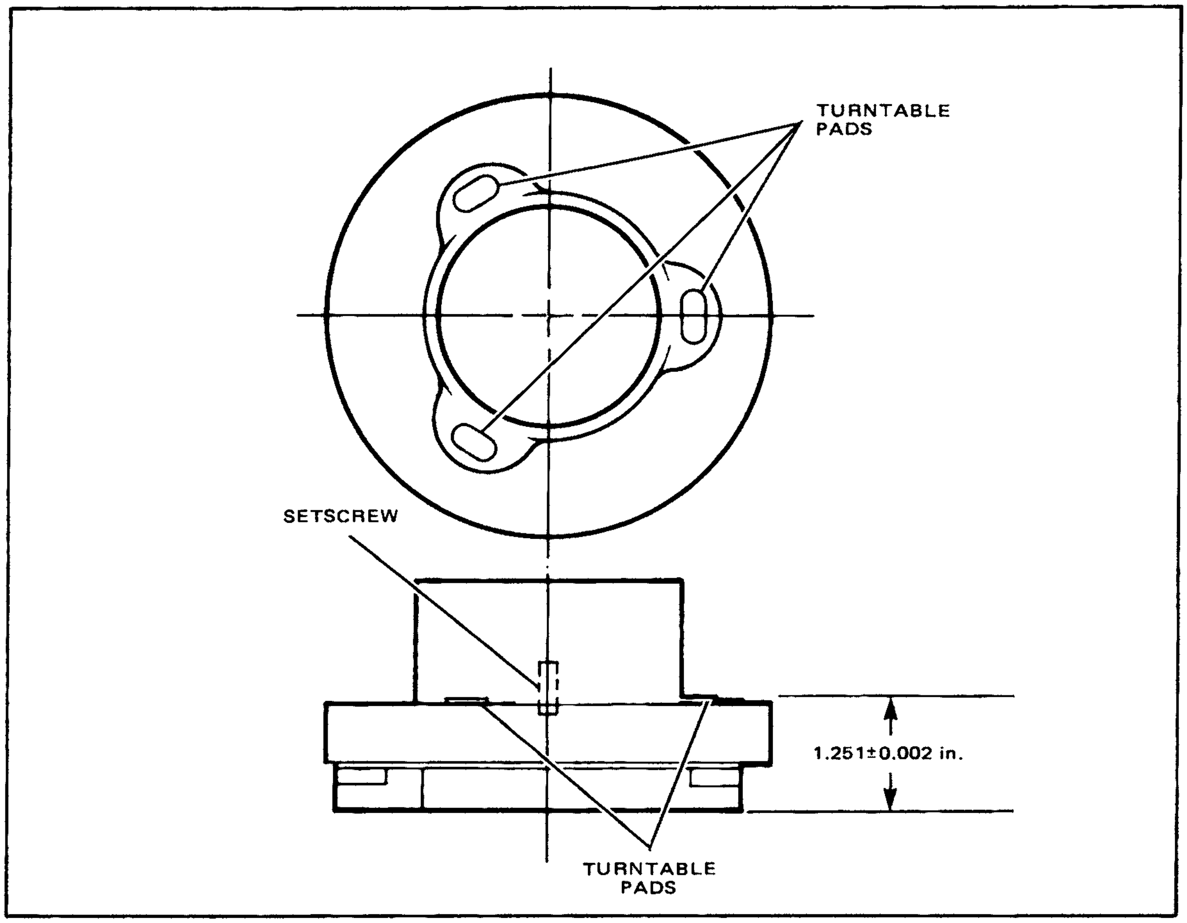


Figure 6-21. Setting Turntable Assembly Height

b. Use a vernier caliper to measure height from bottom of turntable assembly to each of three raised areas, as shown in Figure 6-21. Turntable height must be 1.251 ±0.002 in. (31.78 ±0.0508 mm) at each location measured.

Note

Do not measure turntable height by placing calipers on cork turntable pads. Calipers must contact raised area immediately adjacent to pads.

c. Use a 3-32 hex-drive wrench to adjust elevation setscrew to obtain correct height reading (see Figure 6-21). Turning setscrew clockwise increases height.

STEP 12 After correct turntable height is established, tighten turntable clamp assembly in the following sequence: First tighten the two clamp screws to 29 in/lb (3.28 N/m), then tighten cone-point setscrew (located in V-groove of motor shaft) to 13 in/lb (1.47 N/m).

Note

Ensure that turntable clamp assembly setscrew is positioned in groove on motor shaft before tightening clamp screws.

STEP 13 Recheck turntable height. If necessary, repeat steps 11 and 12.

STEP 14 Reinstall retainer screw removed in step 2.

STEP 15 Reinstall reel motor assembly into transport in reverse order of removal.

6-31 Reel Motor Brush Replacement

The reel motor has two brushes which seldom wear out. However, if a brush should wear out or become noisy, replace as follows:

STEP 1 Remove reel motor assembly from transport as described in paragraph 6-28.

STEP 2 To remove motor brush, use a large-bladed screwdriver and unscrew motor endplug. Brush has a spring attached which maintains pressure against motor commutator. Slide old brush out of motor brush holder.

STEP 3 Clean new brush with isopropyl alcohol and allow brush to dry before installing into motor.

STEP 4 Secure new brush and spring with endplug removed in step 2.

STEP 5 Reinstall reel motor assembly into transport in reverse order of removal. See paragraph 6-28.

6-32 Stationary Tape Guide

Entire stationary tape guide should not be removed unless it is necessary to replace entire unit, because it is factory aligned for position. Tape guide portion can be removed using the following procedure. Refer to Figure 6-22 as required.

STEP 1 Loosen 6-32 cross-recessed panhead screw in tape guide cap, while holding guide post.

STEP 2 Gently pull guide post off base.

STEP 3 Inspect guide post for wear. If excessive wear or uneven surface is present, replace post. A piece of 26 AWG wire is wound around screw inside guide post to provide a conductive path to base. Save wire. Check tape edge guides for chips or cracks, and replace if necessary. Do not lubricate assembly.

STEP 4 To replace assembly, wind wire around thread of panhead screw forming 1/2-inch-long coil. Position coil in center of screw. Loosen coil slightly by twisting in opposite direction. Insert screw with coil through guides and post, and fasten to base. Check post for conductivity to base.

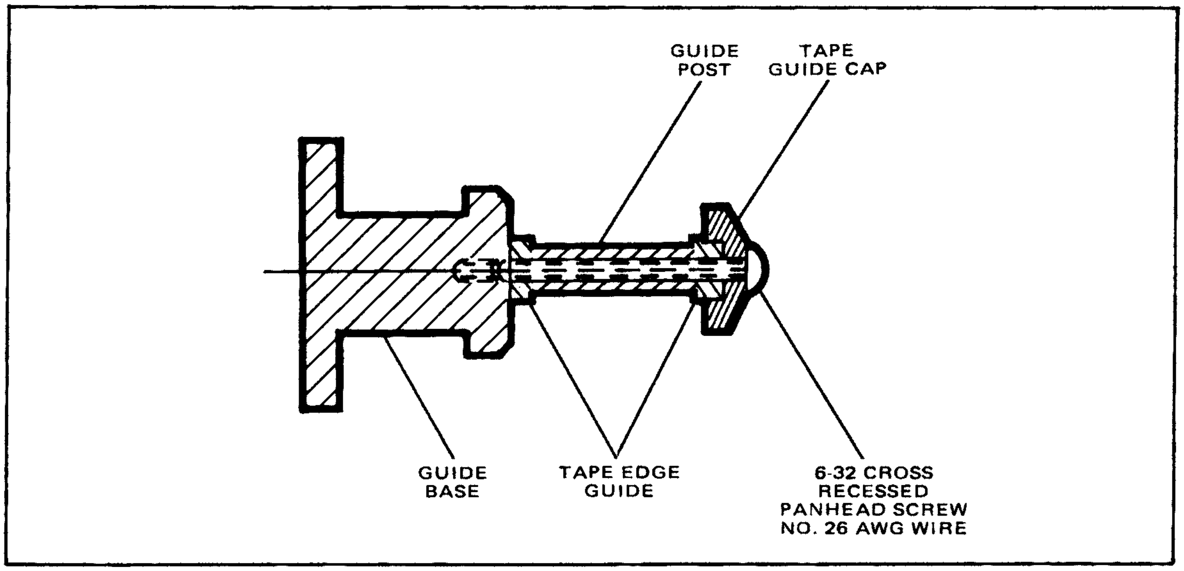


Figure 6-22. Stationary Tape Guide Assembly

6-33 Tension Arm Removal and Replacement

The following procedure details tension arm assembly removal and replacement. Refer to Figure 6-23 for an illustration of the tension arm. Tension arms are similar in design, with mechanical orientation differences.

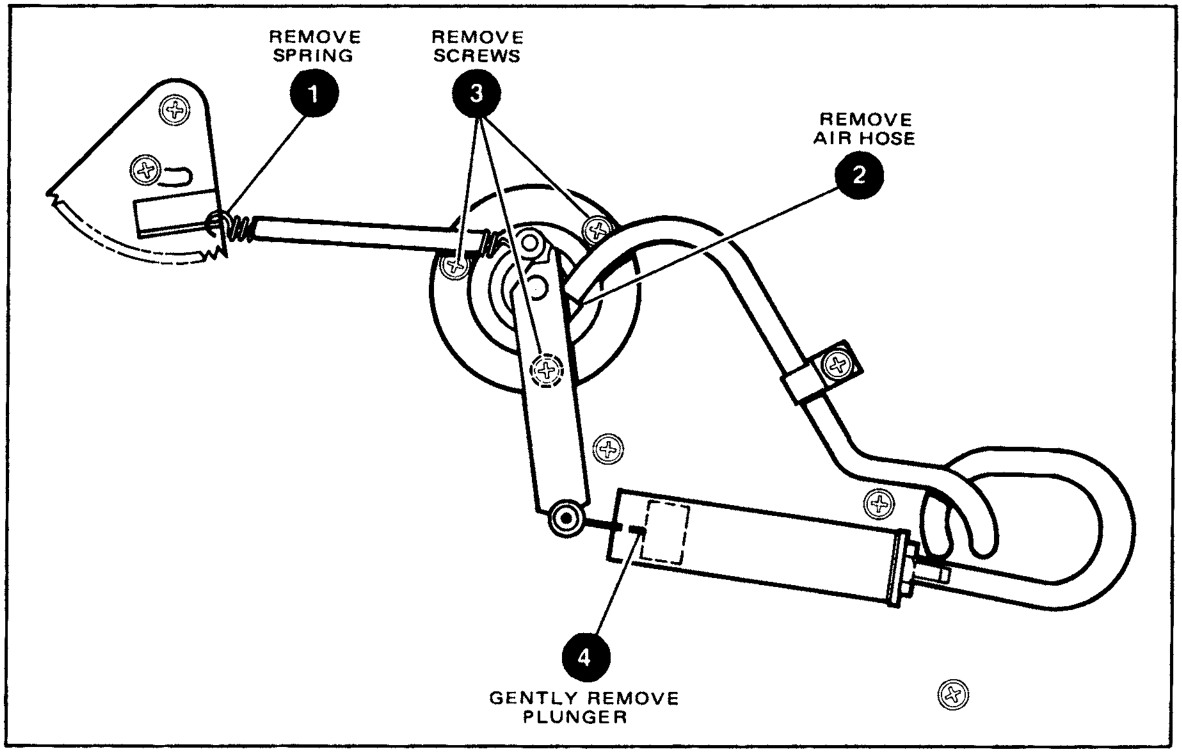


Figure 6-23. Tension Arm Removal

Note

Before starting this procedure, set aside a rubber band (approximately 2 in. diameter) or piece of string for use in step 6.

STEP 1 Remove extension spring at spring anchor.

STEP 2 Remove air hose at tension arm.

STEP 3 Remove three screws, starting with bottom screw, while letting tension arm rest against hand holding assembly.

STEP 4 Gently pull out plunger from air dashpot while gently pulling tension arm out of recess.

STEP 5 Hold plunger and disconnect wiring connector J1 on back of assembly.

STEP 6 Set tension arm down and fasten rubber band or string around wiring connector, and tie to stationary guide assembly. If this wiring connector slips behind top plate, it can be difficult to retrieve, and may require removal of air system.

To replace tension arm:

STEP 1 Connect wiring connector.

STEP 2 Gently replace plunger in airpot while reinserting tension arm in recess.

STEP 3 Line up screw holes. Tension arm can be mounted in one position only, since stops prevent screw holes from lining up in different pattern. Insert screws.

STEP 4 Make sure air hose has no crimps, and replace on tension arm fitting.

STEP 5 Reconnect spring to spring anchor. Make sure supply and takeup springs are not accidentally switched.

6-34 Video Erase Head Assembly Removal

The video erase head assembly is removed and replaced using procedure detailed below. Refer to Figure 6-24.

STEP 1 Remove trim plate, following directions in paragraph 6-27.

STEP 2 Remove bottom wiring connector on video erase head assembly.

STEP 3 Gently pull top wiring connector from recessed hole and hold both parts to disconnect wiring harness.

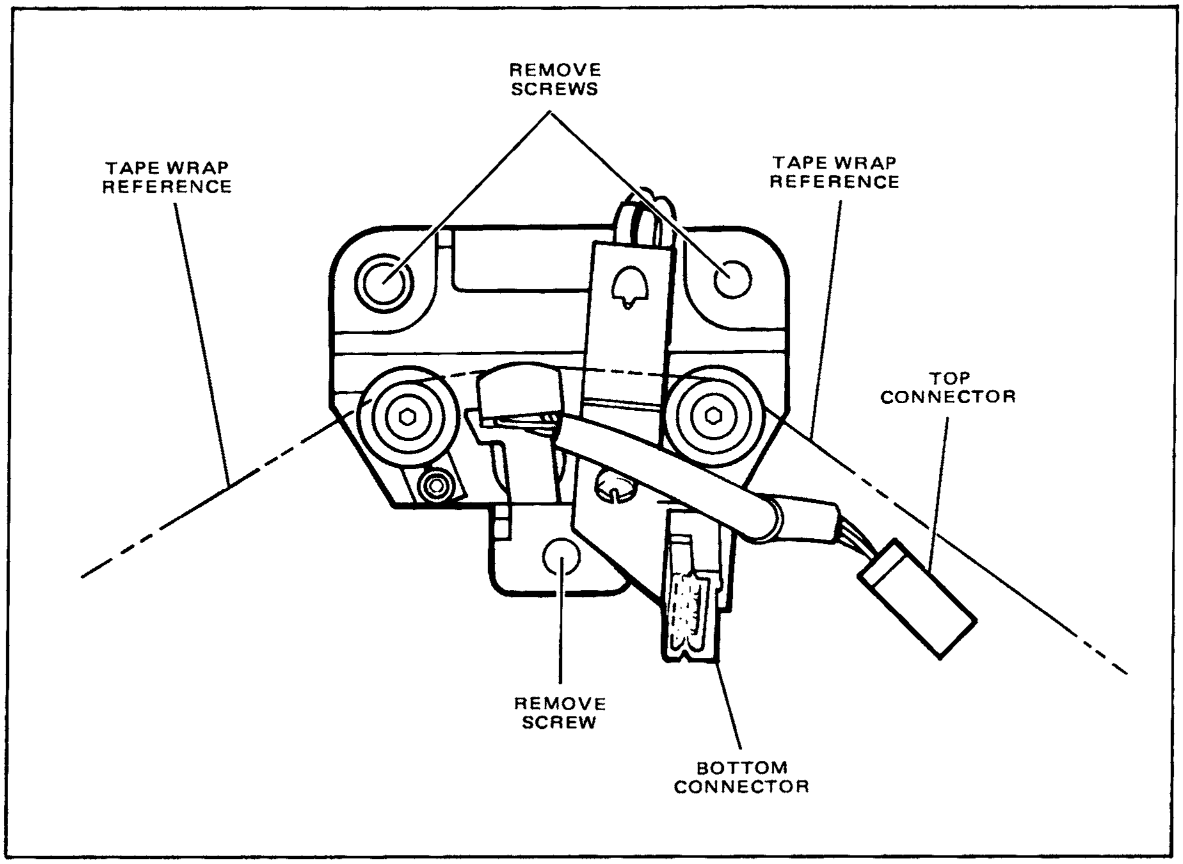


Figure 6-24. Video Erase Head Assembly Removal

STEP 4 Remove three 8-32 panhead cross-recessed screws with washers. Remove bottom screw last and hold in place while removing entire assembly from top plate. Check for "O" ring around air intake hole behind assembly. Leave "O" ring in place.

To replace video erase head assembly, reverse steps 1 through 4. Make sure "O" ring is in position. Align assembly using locating studs, and replace securing screws.

6-35 Video Erase Head Assembly Disassembly

STEP 1 Remove video erase head assembly following directions in paragraph 6-34.

STEP 2 To remove video erase head stack, first remove 6-32 panhead cross-recessed screw securing wiring harness clip (see Figure 6-25 (A)). Remove 4-40 hex socket head screw securing head stack.

To replace head stack, carefully unsolder four leads (see Figure 25 (A)), noting position of each lead. Replace heat-shrink tubing if necessary. Solder leads onto new stack, avoiding excess solder (see Figure 25 (B)).

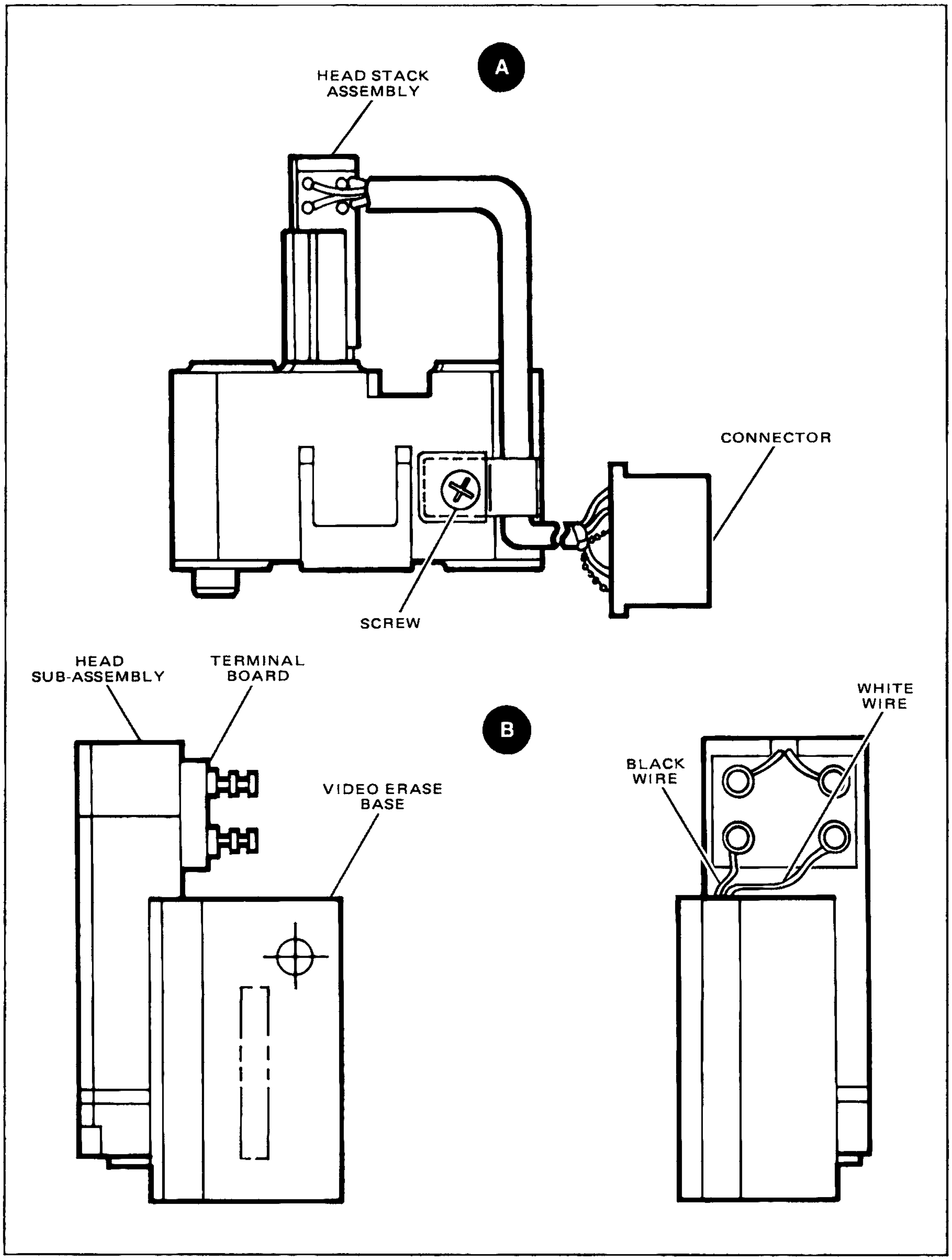


Figure 6-25. Video Erase Head Assembly–Head Stack

STEP 3 To replace tape-in-path sensor, first remove screw holding wiring connector. Remove 4-40 hex socket head screw securing sensor to base. Figure 6-26 shows a side view of the sensor.

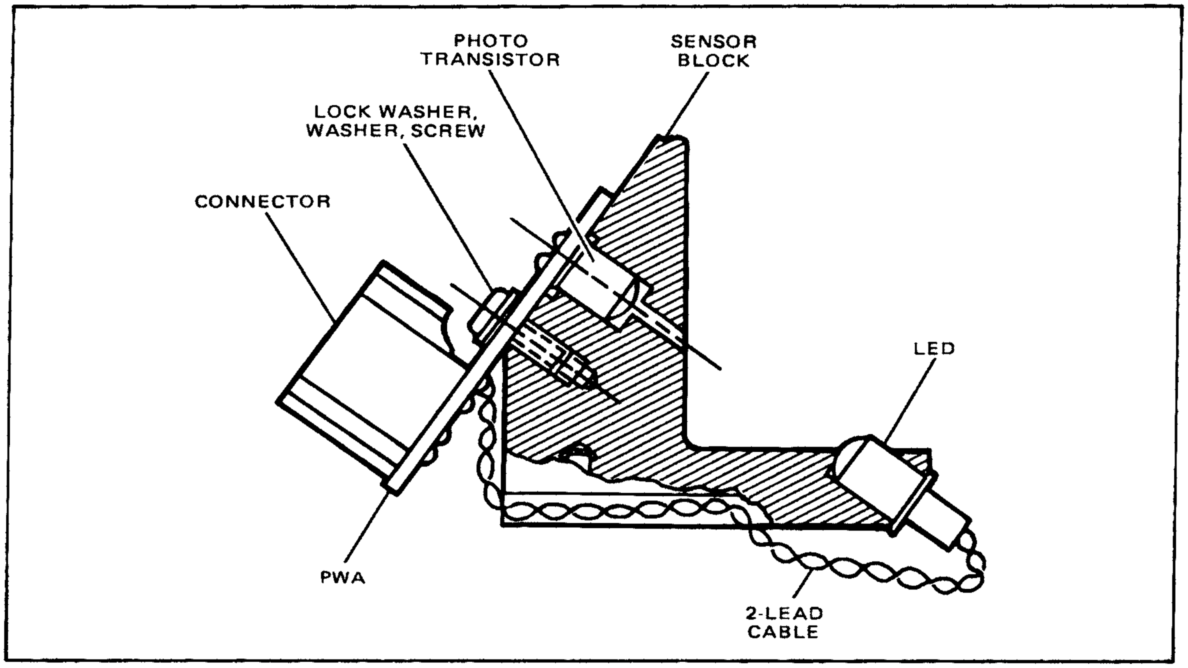


Figure 6-26. Tape-in-Path Sensor

Note

When replacing sensor unit, position two-lead cable so that it is not in tape path.

STEP 4 Figure 6-27 shows cutaway details of the inertia roller assembly. The inertia roller can be partially disassembled by removing the 4-40 flathead hex-socket screw. The idler moves on two bearing assemblies, with the top one spring-loaded. Note order of components when reassembling the inertia roller. The shaft itself is secured with loctite adhesive into the base and should not be removed.

STEP 5 Air guide assembly is also shown in Figure 6-27. The air guide itself can be removed for cleaning by loosening the 4-40 flathead hex socket screw. Air guide shaft is secured with loctite and a silicone adhesive and should not be disturbed.

To reassemble video erase head stack assembly, reverse order of disassembly.

6-36 Edit Erase PWA Removal and Replacement

The Edit Erase PWA is located above the scanner assembly (refer to Figure 6-1), and contains circuitry for the video edit erase operation. Figure 6-28 shows the schematic for the Edit Erase PWA.

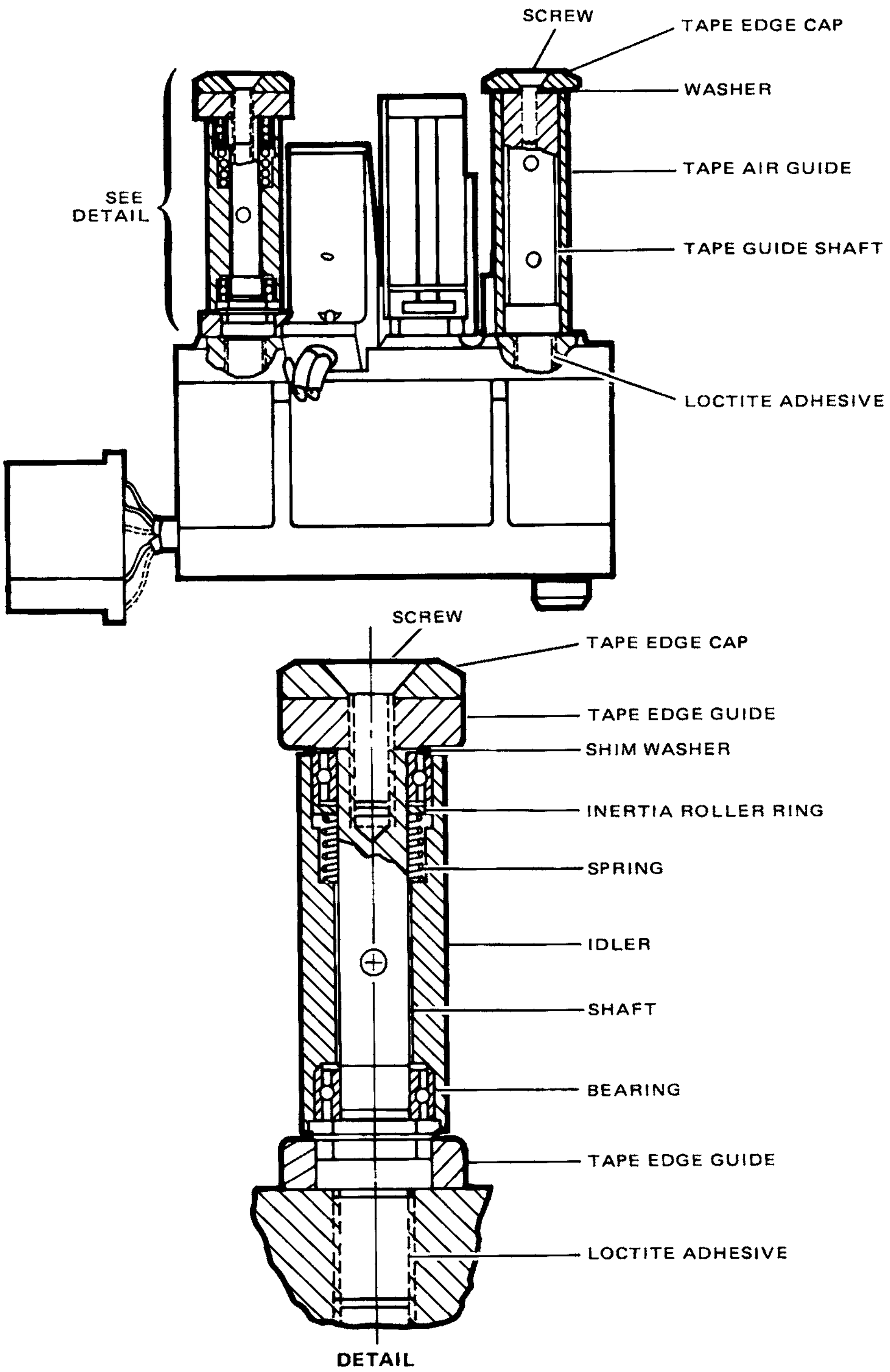


Figure 6-27. Inertia Roller and Air Guide in Video Erase Head Assembly

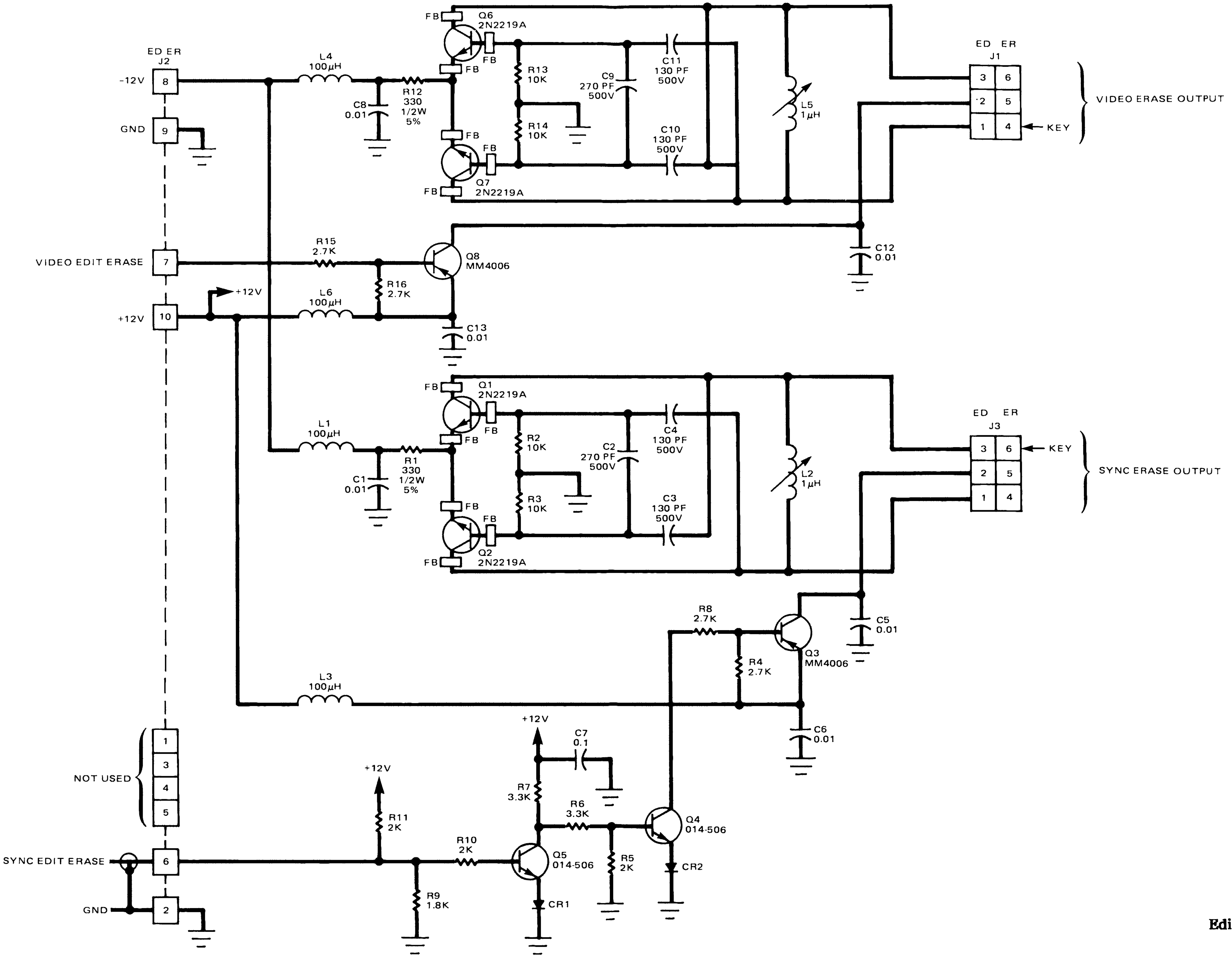


Figure 6-28.
Edit Erase PWA Schematic

To remove:

STEP 1 Remove protective trim piece (see paragraph 6-27).

STEP 2 Remove three wiring harness connectors (J1, J2, J3) from bottom of PWA (see Figure 6-29 (A)).

STEP 3 Remove three 8-32 panhead cross-recessed screws securing PWA (Figure 6-29 (B)).

To replace Edit Erase PWA, reverse steps.

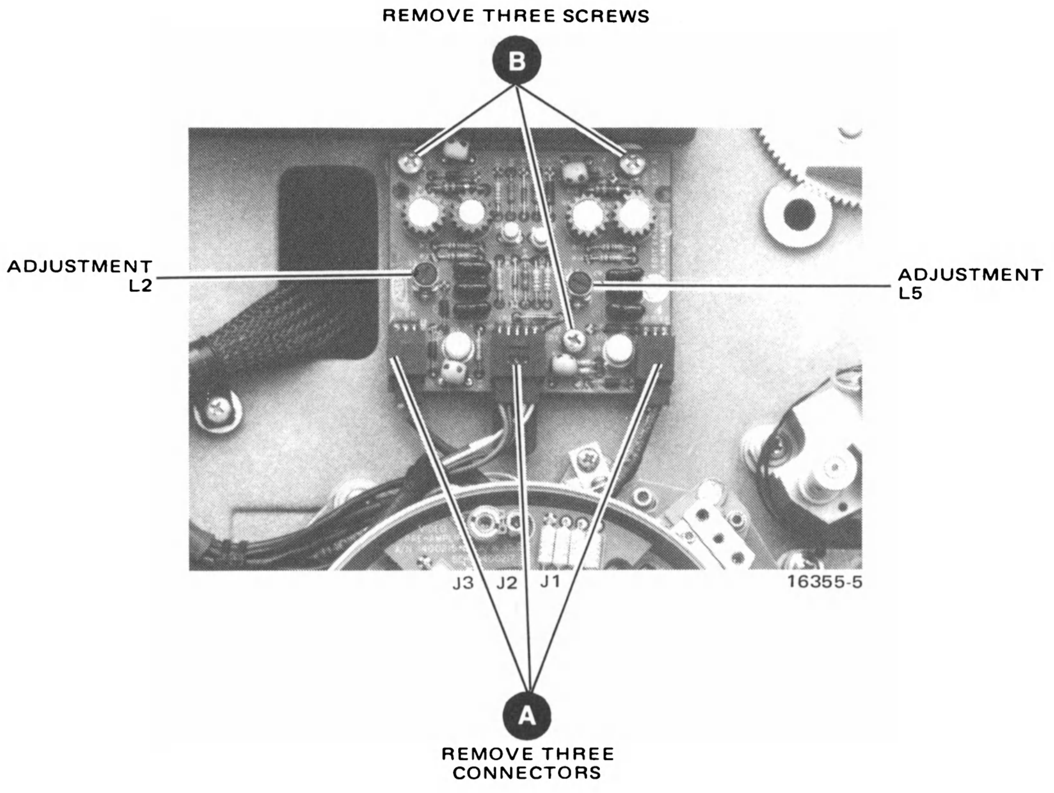


Figure 6-29. Edit Erase PWA

6-37 Scanner Removal and Replacement

The following procedure details removal and replacement of entire scanner assembly, including tape guides. If tape guide-to-scanner distance changes, it must be reset (see paragraph 6-48 on interchange procedures for details).

The scanner assembly does not have to be removed for video head replacement (see paragraph 6-38). The guide assembly can also be removed separately.

To remove:

STEP 1 Remove transport protective trim as described in paragraph 6-27.

STEP 2 Remove three connectors on Edit Erase PWA (see Figure 6-30 (A)).

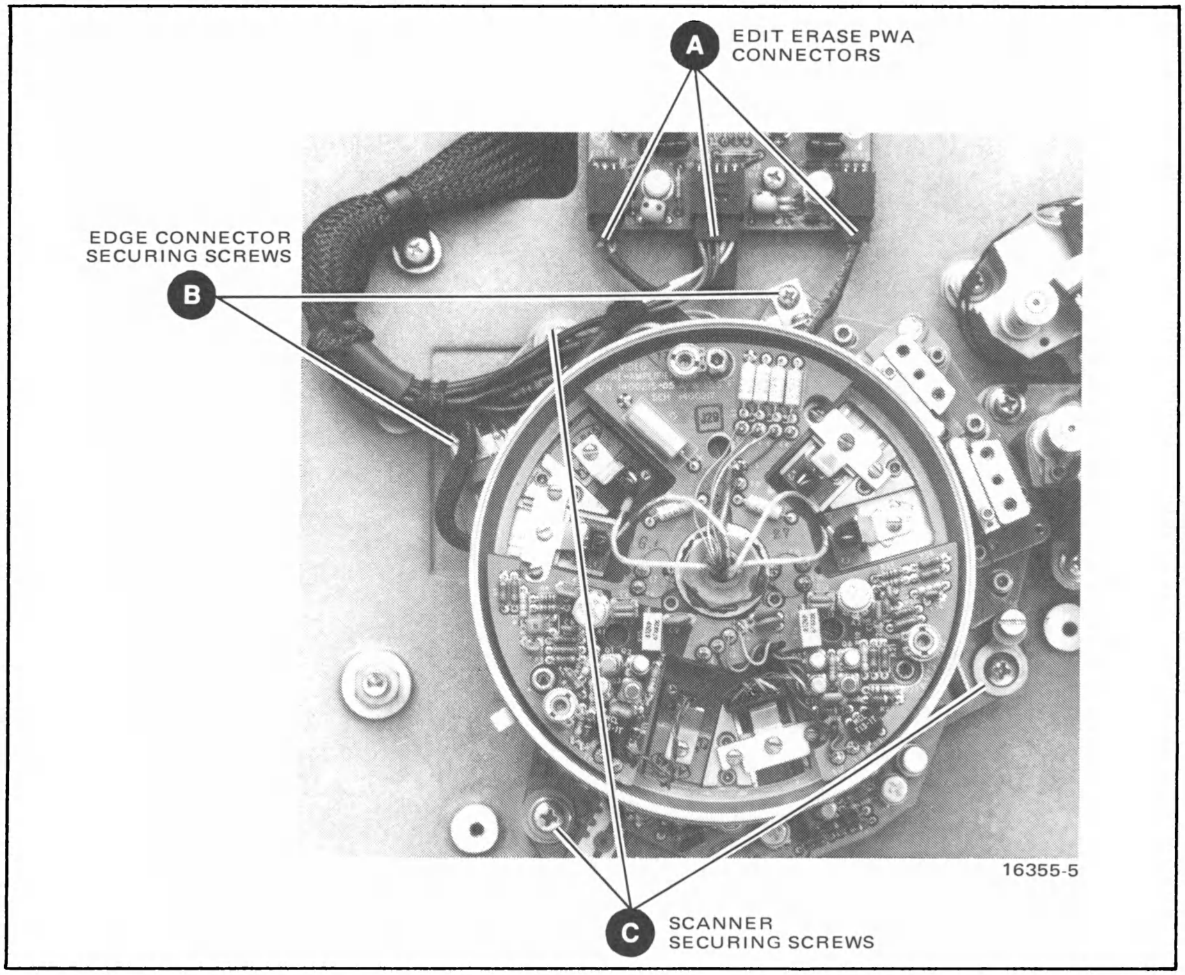


Figure 6-30. Scanner Assembly Mounting

STEP 3 Remove two cross-recessed screws securing Video Record Amplifier PWA edge connector to scanner assembly (see Figure 6-30 (B)).

STEP 4 Remove three 10-32 cross-recessed screws securing scanner assembly to transport top plate (see Figure 6-30 (C)). Top two screws have washer attached to screw, while bottom screw with separate washer and lock washer goes into counter-bored hole.

CAUTION

WHEN HANDLING SCANNER ASSEMBLY, DO NOT TOUCH PROTRUDING HEAD TIPS.

STEP 5 Rotate scanner clockwise to extract scanner from cavity in top plate far enough to allow rear connectors to be reached.

STEP 6 Disconnect two connectors at rear of scanner by pinching connectors and pulling, and withdraw assembly completely from transport.

STEP 7 Remove air hose.

STEP 8 Scanner installation is the reverse of this procedure. When installing scanner into transport top plate, ensure that scanner mounts flush to casting with no interfering components between mating surfaces. Also make sure air hose is not crushed and screws are inserted correctly.

Note

If existing scanner assembly is replaced by a new assembly, interchangeability must be ensured as outlined in paragraph 6-48.

6-38 Video Head Replacement

Video heads can generally be replaced without removing the scanner assembly from the VPR-3. Extreme care must be taken when replacing video heads to avoid damaging delicate parts (such as tips and connector leads).

CAUTION

IF AST PLAY HEAD IS REPLACED, AST ALIGNMENT PROCEDURES MUST BE PERFORMED. SEE PARAGRAPH 3-36.

Table 6-2 lists head assemblies used on the VPR-3. Figure 6-31 head assembly shows head assembly location, three head registration lock/release screws, and head securing devices. The AST play head, video erase head, and video record head are each secured by a head clamp assembly. The three sync heads are held in place with sync head brace secured by a single screw. A lip is provided on each head clamp to support the signal connector and counteract centrifugal force resulting from scanner rotation.

To replace a head, proceed as follows, referring to Figure 6-32 as necessary:

STEP 1 Remove power from VPR-3.

STEP 2 Remove tape from scanner assembly.

STEP 3 Remove scanner top cover by loosening three slotted screws.

STEP 4 To preclude the possibility of a tool striking the entrance or exit guide, rotate scanner clockwise so that head to be changed points away from entrance or exit guide.

STEP 5 To change an AST head, erase head, or record head, perform the following steps. (To change a sync head, proceed to step 6.)

Table 6-2. Video Head Assemblies

Head Description
Video Record/Play Head, 60 Hz
Video Record/Play Head, 50 Hz
Automatic Scan Track (AST) Head, 60 Hz
Automatic Scan Track (AST) Head, 50 Hz
Video Erase Head, 60 Hz
Video Erase Head, 50 Hz
Sync Dummy Head
Sync Record/Play Head, 60 Hz
Sync Record/Play Head, 50 Hz
Sync Erase Head, 60 Hz
Sync Erase Head, 50 Hz

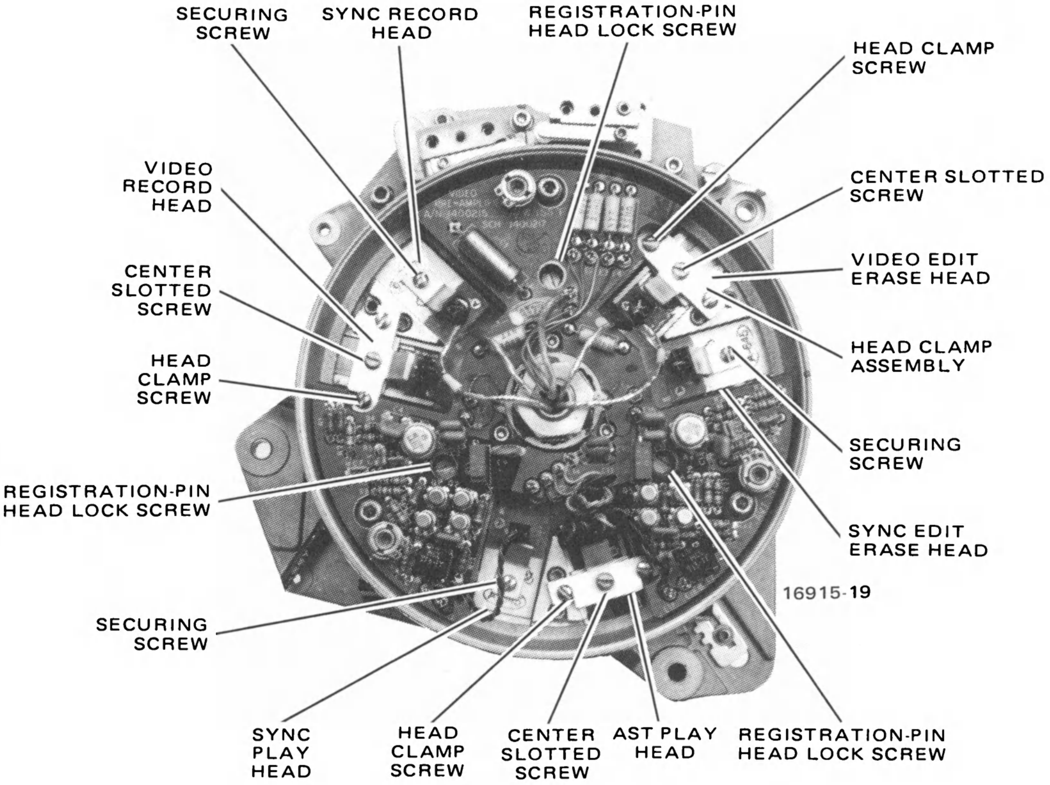
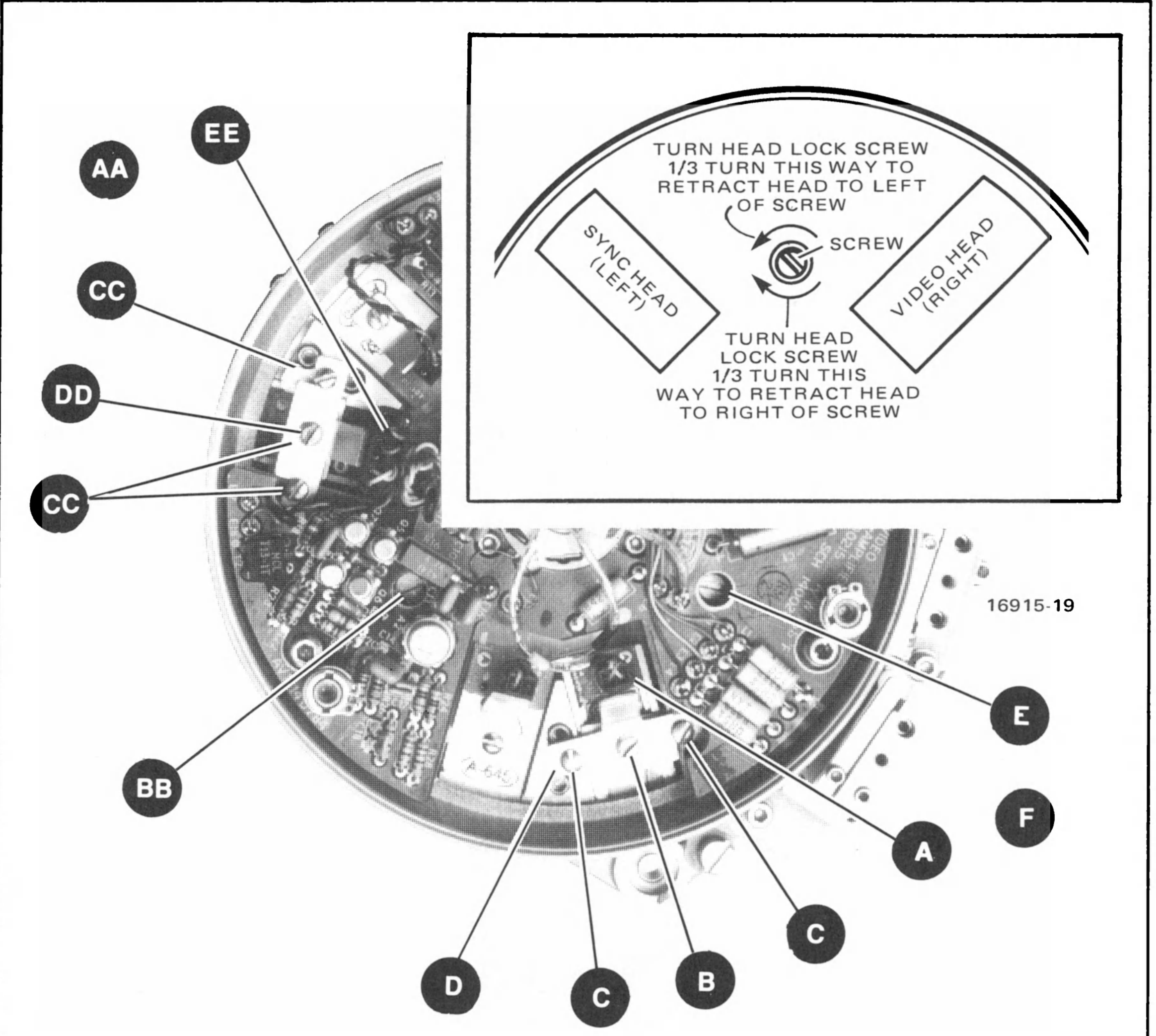


Figure 6-31. Scanner Video Heads and Head Securing Devices


TURN HEAD LOCK SCREW 1/3 TURN THIS WAY TO RETRACT HEAD TO LEFT OF SCREW
SCREW
SYNC HEAD (LEFT)
VIDEO HEAD (RIGHT)
TURN HEAD LOCK SCREW 1/3 TURN THIS WAY TO RETRACT HEAD TO RIGHT OF SCREW
AA
EE
CC
DD
CC
BB
16915-19
E
F
A
C
D
C
B

A	CAREFULLY REMOVE CONNECTOR
B	TURN SCREW COUNTERCLOCKWISE
C	TURN SCREWS COUNTERCLOCKWISE
D	SLIP HEAD CLAMP ASSEMBLY LOOSE
E	TURN HEAD LOCK SCREW AS SHOWN IN INSERT
F	REMOVE HEAD
AA	SLIDE NEW HEAD IN PLACE
BB	TIGHTEN HEAD LOCK SCREW
CC	SLIDE HEAD UNDER CLAMP AND TIGHTEN SCREWS
DD	TIGHTEN SCREW
EE	INSERT HEAD CONNECTOR

Figure 6-32. Video Head Replacement

a. Carefully disconnect head connector by pulling connector straight up (see Figure 6-32 (A)). Avoid placing any strain on connector wires.

b. Loosen center slotted screw in head clamp assembly. See Figure 6-32 (B).

c. Turn two slot-head head clamp screws two turns counterclockwise so that bridge can be slipped from underneath them. See Figure 6-32 (C).

d. Each head assembly is held in position within the scanner assembly by a registration pin. Access to the registration-pin head lock release is through a hole in the Preamplifier PWA that is nearest the head to be changed (Figure 6-32). To retract the registration pin from the head, turn head lock screw away from center detent until it stops (approximately one-third turn) in direction shown. See Figure 6-32 (E).

e. Carefully slide head back toward center of scanner casting and raise head assembly rear end while removing head from scanner. See Figure 6-32 (F).

f. Check that there is no dirt or lint on scanner (use clean compressed air if available). Clean scanner if necessary.

g. Carefully slide new head in place into scanner while taking care not to hit head tip. Slide head all the way forward toward scanner outer edge. See Figure 6-32 (AA).

h. Lock head against registration pin by turning registration-pin head lock screw clockwise to center detent. See Figure 6-32 (BB).

CAUTION

EACH REGISTRATION-PIN HEAD LOCK SCREW CONTROLS THE REGISTRATION PINS OF THE TWO NEAREST HEADS. THESE SCREWS MUST BE RETURNED TO CENTER DETENT POSITION TO ENSURE THAT HEADS THEY CONTROL ARE LOCKED, AND THAT SCANNER BALANCE IS OPTIMIZED.

i. Slide head clamp under the two securing screws; tighten screws. See Figure 6-32 (CC). Tighten center slotted screw in head clamp. See Figure 6-32 (DD).

j. Align head connector with head connector pins and gently insert head connector. See Figure 6-32 (EE). Table 6-3 lists color coding of head connector leads.

k. Rotate scanner slowly by hand to verify that heads do not touch scanner guides.

STEP 6 To change a sync head, perform the following steps:

a. Unscrew the single slot-head screw that secures head and connector brace to scanner casting. Remove brace and screw.

Table 6-3. Head Connector Color Coding

Head	Connector Color Code
AST	Black, Red, Brown, Red, Orange, Yellow
Sync/Playback	Black, Red
Video Record	Red, Brown
Sync Record	White, Green
Video Edit Erase	Yellow, Blue
Sync Edit Erase	Black, Orange

b. access to registration-pin head lock is through a hole in the Preamplifier PWA that is nearest the head being changed. Turn head lock screw clockwise from center detent until it stops (about 1/3 turn) to retract registration pin from the head.

c. Carefully slide head back toward center of casting, and raise rear end of head assembly while removing head from scanner.

d. Check that there is no dirt or lint on scanner (use clean compressed air if available).

e. Carefully slide new head in place into scanner while taking care not to hit head tip. Slide head all the way forward toward scanner outer edge.

f. Lock head against the registration pin by turning the registration-pin head lock screw counterclockwise to center detent.

CAUTION

EACH REGISTRATION-PIN HEAD LOCK SCREW CONTROLS THE REGISTRATION PINS OF THE TWO NEAREST HEADS. THESE SCREWS MUST BE RETURNED TO CENTER DETENT POSITION TO ENSURE THAT HEADS THEY CONTROL ARE LOCKED, AND THAT SCANNER BALANCE IS OPTIMIZED.

g. Reinstall slot-head screw and connector brace removed in step 6A. Tighten screw just enough to hold head in place (do not overtighten screw).

CAUTION

DO NOT APPLY HEAD DATA GUMMED LABEL FROM HEAD BOX TO ROTATING SCANNER, AS THIS WILL CAUSE SCANNER TO BE OUT OF BALANCE.

STEP 7 Reinstall scanner top cover removed in step 3, so that identifying label on head cover is aligned with the respective head assembly. (AST Play head has extra leads on the connector.) Do not over-tighten the three screws that secure cover.

6-39 Slip-Ring Brush Replacement

The twelve graphite scanner slip-ring brushes (Ampex Part No. 1463187) have a long life expectancy and should not require frequent replacement. However, if they become broken, damaged, or contaminated, they can be changed as follows:

CAUTION

USE EXTREME CARE NOT TO HIT, SCRAPE, OR OTHERWISE DAMAGE PRECISION SURFACE OF THE SILVER SLIP RINGS. EVEN A MINOR NICK CAN CAUSE ARCING WHICH CAN AFFECT PICTURE QUALITY.

STEP 1 Remove scanner assembly from transport as described in paragraph 6-37. Install scanner onto service leg set assembly (Ampex Part No. 1401302).

STEP 2 With scanner rear facing upward, remove the two screws securing motor cover to scanner assembly.

STEP 3 Remove three cross-recessed screws securing Motor Drive PWA to standoff supports. See Figure 6-33 (A).

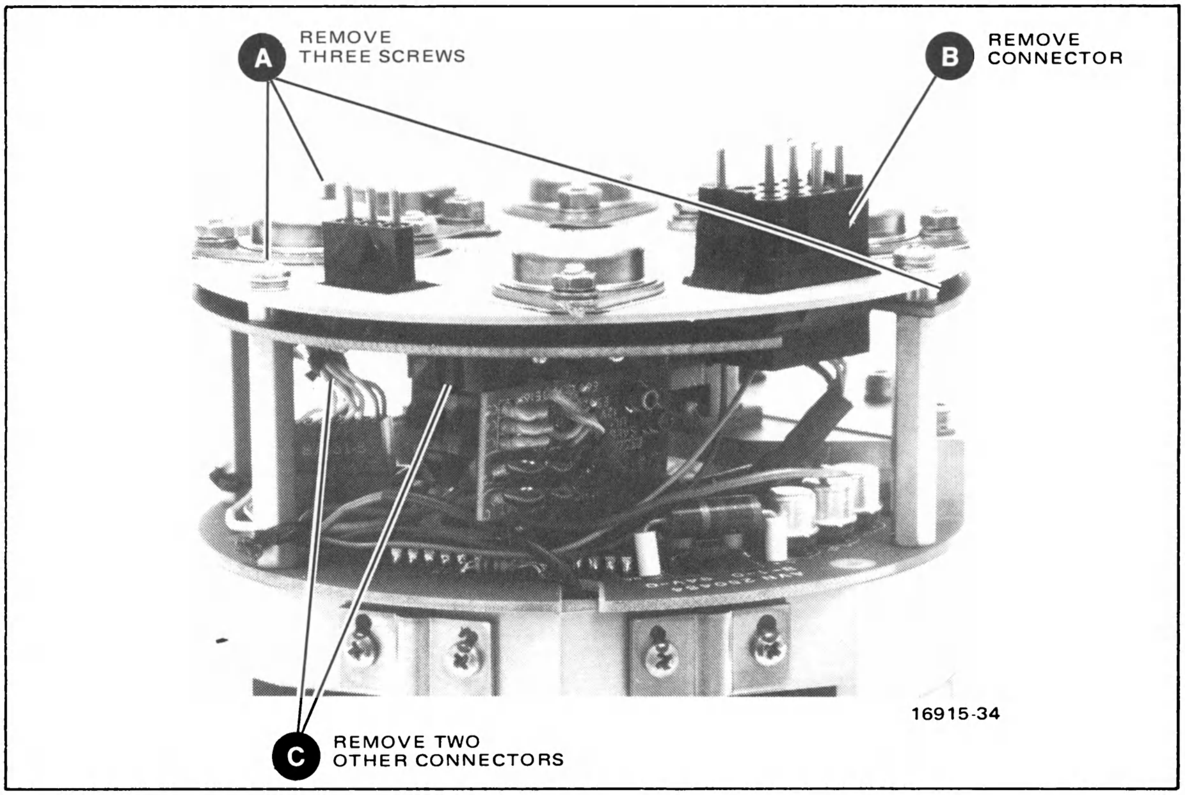


Figure 6-33. Accessing Scanner Slip-Ring Assembly

STEP 4 Remove large connector from PWA by pressing tabs together and pushing through cutout in plate. See Figure 6-33 (B).

STEP 5 Remove two other connectors on underside of PWA plate, and set plate aside. See Figure 6-33 (C).

STEP 6 Gently push spring aside (see Figure 6-34 (A)), and remove old brushes with tweezers (Figure 6-34 (B)).

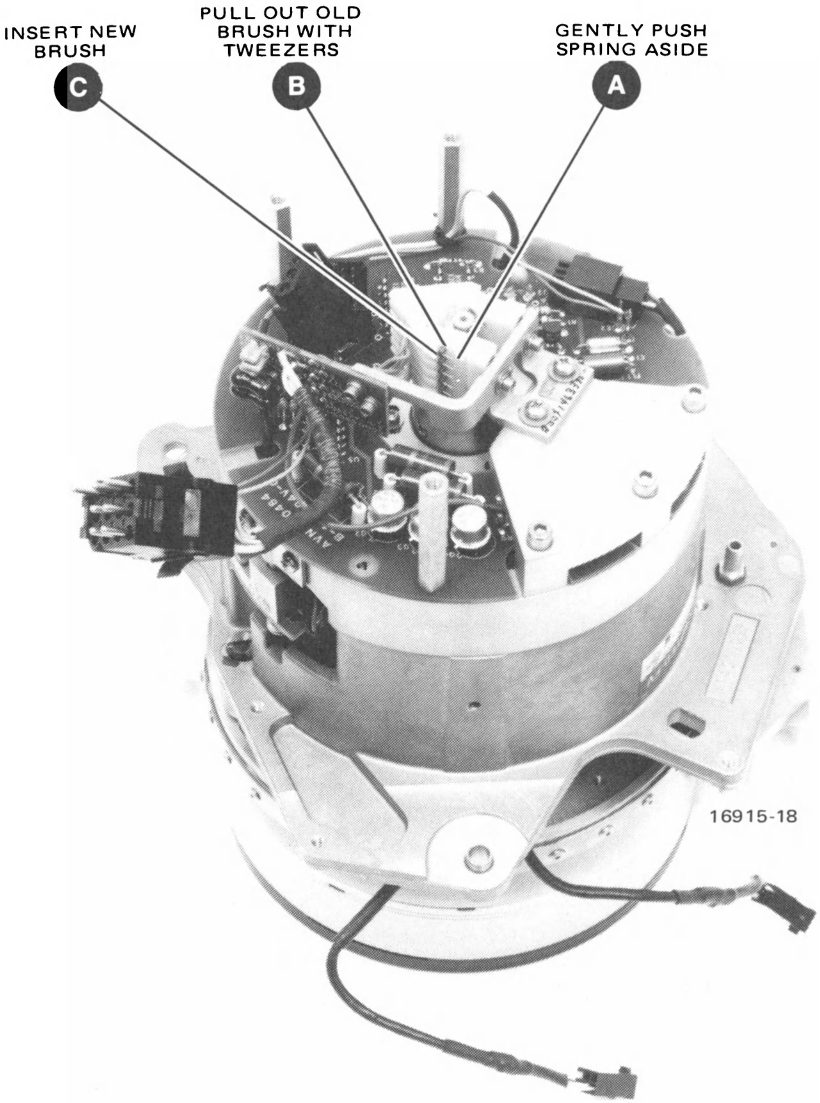


Figure 6-34. Scanner Slip-Ring Brush Replacement

STEP 7 Very carefully install new carbon brushes with V-groove end out. Place brush retaining springs back into place over brush ends. Examine each brush to verify that spring wire is resting in the V-groove in end of brush. See Figure 6-34 (C).

STEP 8 Replace Motor Drive PWA plate and connectors.

STEP 9 Reinstall scanner motor cover (two screws) and remove scanner service leg assembly.

STEP 10 Reinstall scanner assembly into transport as described in paragraph 6-37.

6-40 Slip-Ring Assembly Replacement

The slip-ring assembly has a long life expectancy and should normally not require replacement. However, nicks, grooves, or other damage to silver rings can cause arcing which can affect picture quality. In such cases, the slip-ring assembly should be replaced.

The slip-ring assembly is mounted on top of the collar adapter. Three sets of shielded connecting wires feed from it through the scanner assembly center and connect to terminals on the Preamplifier PWA. This PWA is located on the upper (rotating) drum of the scanner assembly. Figure 6-35 shows the wiring schematic.

Replace slip-ring assembly using the procedure below. Note that a dial indicator tool is required for setting runout.

CAUTION

USE EXTREME CARE NOT TO HIT, SCRAPE, OR OTHERWISE DAMAGE PRECISION SURFACE OF THE SILVER SLIP RINGS. EVEN A MINOR NICK CAN CAUSE ARCING WHICH CAN AFFECT PICTURE QUALITY.

STEP 1 Remove scanner assembly from transport, as described in paragraph 6-37.

STEP 2 Invert scanner so that rotating drum is facing up and remove cover.

STEP 3 Unsolder six slip-ring wires from Preamplifier PWA terminals E1, E2, E3, E4, E5, and E6. See Figure 6-36. Note color of wires.

STEP 4 Place scanner on service leg assembly and remove bottom shield cover.

STEP 5 Remove three cross-recessed screws securing Motor Drive PWA to its standoff supports.

STEP 6 Remove large connector from PWA by pressing tabs together and pushing through cutout in plate. Remove two other connectors from underside of PWA plate.

STEP 7 Unfasten three socket-head screws securing slip-ring brush housing support bracket to scanner assembly. See Figure 6-37.

STEP 8 Slide brush housing in the direction shown in Figure 6-37, allowing brushes to come together so that brush housing can be lifted free of slip-ring assembly.

STEP 9 Move 12 brush retaining springs aside, one at a time, and withdraw old brushes.

STEP 10 Insert brush installation tool (Ampex Part No. 1463203) into brush housing as shown in Figure 6-38. Tool holds brushes in a spread position until brush housing is mounted in place around slip-ring assembly.

STEP 11 Remove brush housing from slip-ring assembly.

STEP 12 Unfasten three 4-40 panhead screws securing slip-ring assembly to collar adapter (see Figure 6-39). Carefully withdraw slip-ring assembly from scanner.

STEP 13 Compare wire lengths of old and new slip-ring assemblies. If necessary, trim leads on new assembly to match lead lengths of the old.

Note

Lead lengths must be exactly duplicated to ensure that scanner balance is maintained.

Step 14 Thread the six wires and braided ground strap of new slip-ring assembly through scanner core to the Preamplifier PWA. Continue threading until slip-ring assembly base mates with its mounting surface on scanner. It may be helpful to temporarily place wires inside a piece of tubing to facilitate threading them through scanner.

STEP 15 Reinstall the three panhead screws removed in step 6. Do not tighten screws.

STEP 16 Using a dial indicator mounted on a stand, place indicator tip at center of number 1 ring (top ring), and adjust indicator for a half-scale reading. See Figure 6-40.

STEP 17 Rotate scanner and observe runout indication on dial. If runout is greater than 0.001 in. (0.024 mm), center slip-ring assembly so that it is concentric. This can be done by light tapping at slip-ring base.

STEP 18 Reposition indicator tip at center of number 6 slip ring (bottom ring) and adjust indicator for half-scale reading. Repeat step 17.

STEP 19 Tighten the three slip-ring mounting screws, and verify that concentricity is still within 0.001 in. (0.024 mm). If necessary, repeat steps 16, 17, and 18.

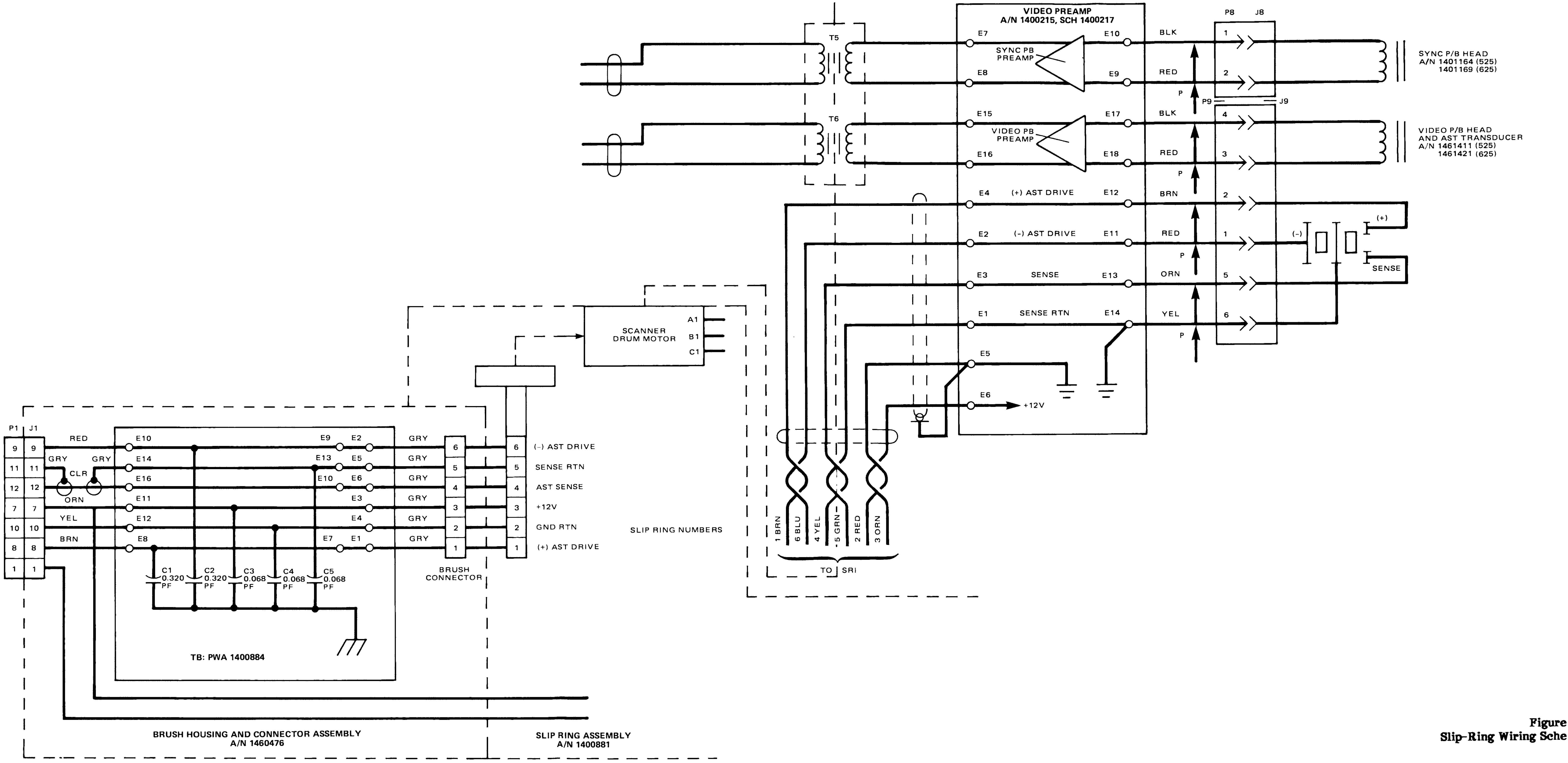
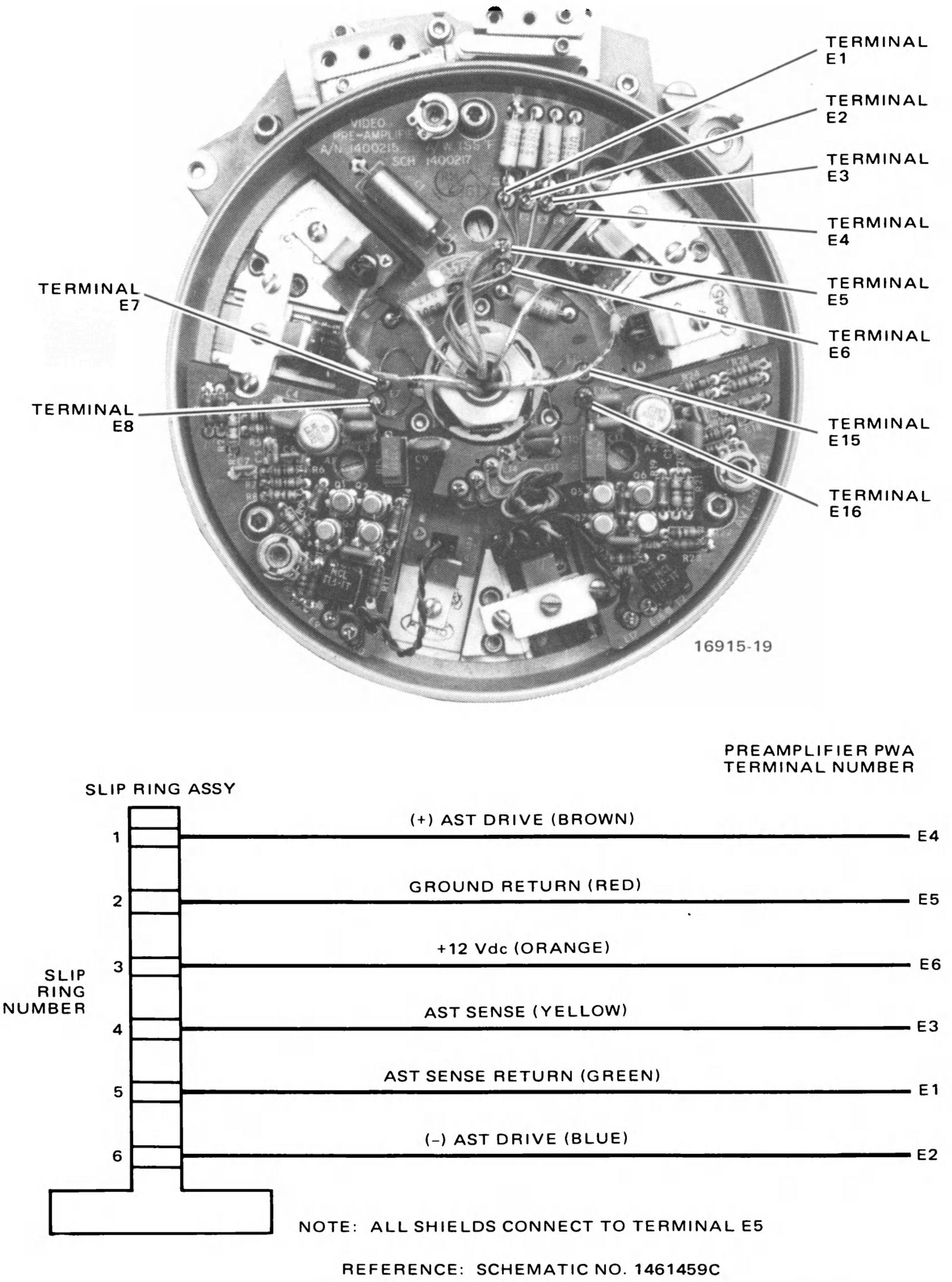


Figure 6-35.
Slip-Ring Wiring Schematic



NOTE: ALL SHIELDS CONNECT TO TERMINAL E5

REFERENCE: SCHEMATIC NO. 1461459C

Figure 6-36. Slip-Ring Wiring Connections to Preamplifier PWA

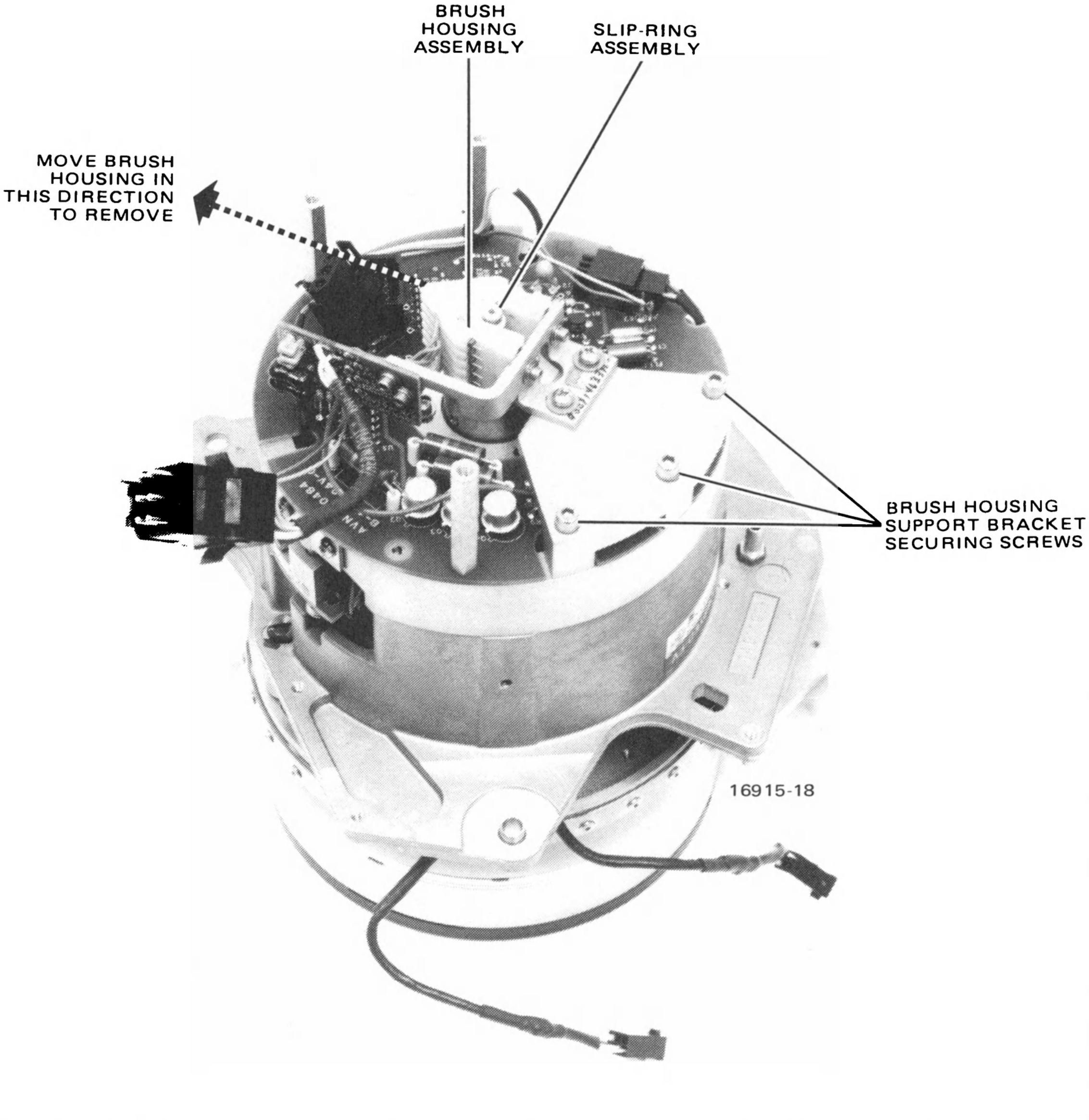

BRUSH HOUSING ASSEMBLY
SLIP-RING ASSEMBLY
MOVE BRUSH HOUSING IN THIS DIRECTION TO REMOVE
BRUSH HOUSING SUPPORT BRACKET SECURING SCREWS
16915-18

Figure 6-37. Scanner Slip-Ring Brush Housing Removal

STEP 20 Remove dial indicator and mounting stand. Clean slip-ring assembly.

STEP 21 Install new slip-ring brushes.

STEP 22 Reinstall the slip-ring brush assembly and Motor Drive PWA.

STEP 23 Reinstall motor cover.

STEP 24 Invert scanner and remove upper drum cover.

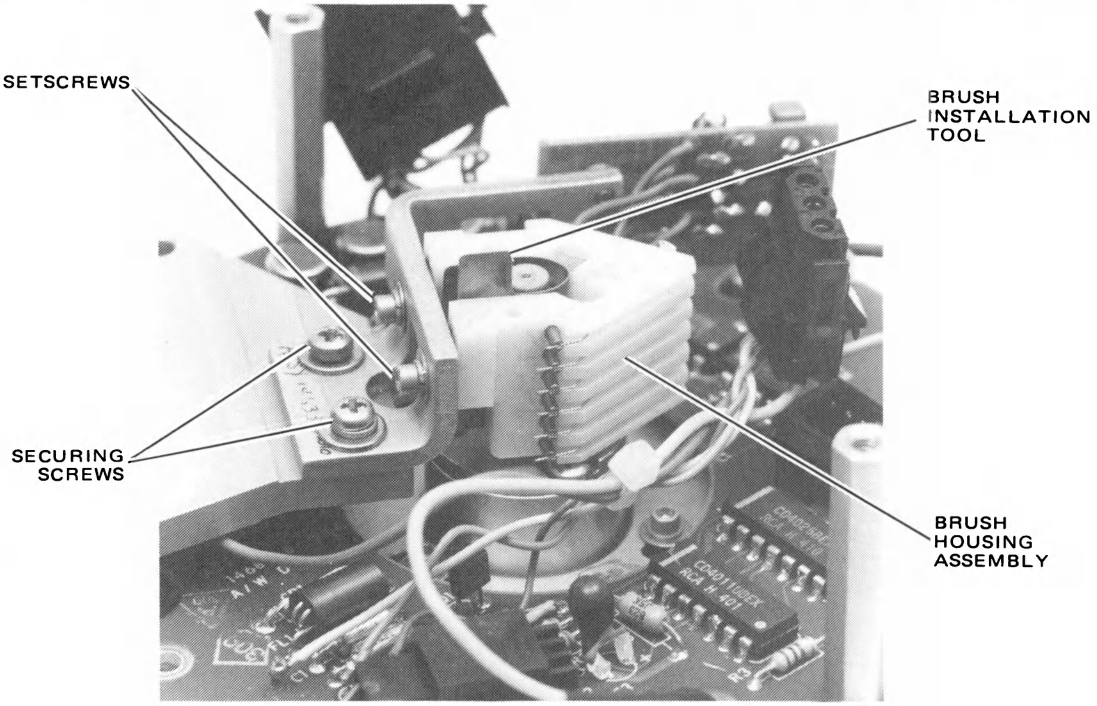


Figure 6-38. Brush Installation Tool Mounted on Brush Housing Assembly

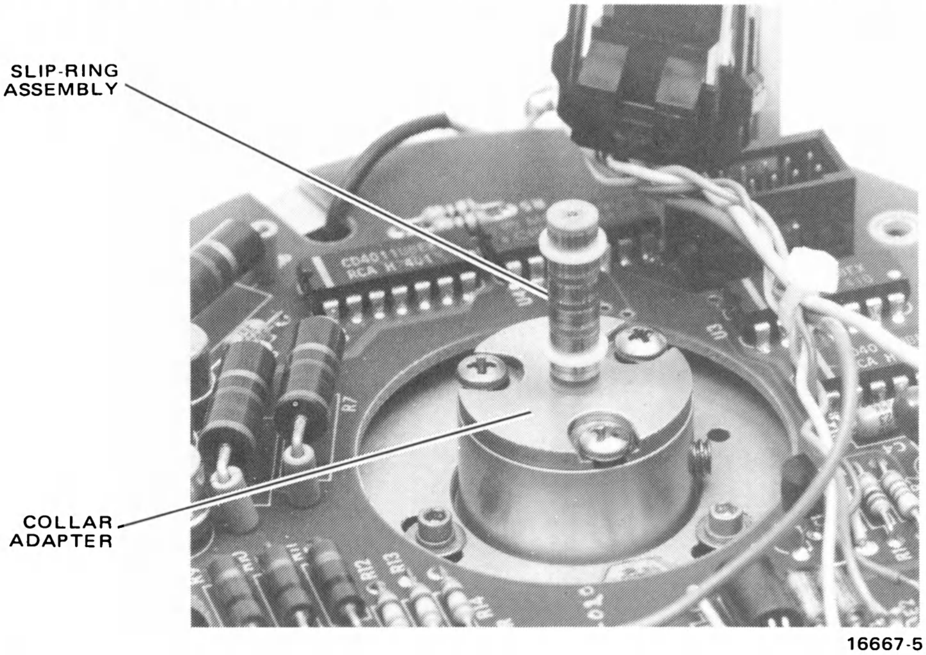


Figure 6-39. Scanner Slip-Ring Assembly

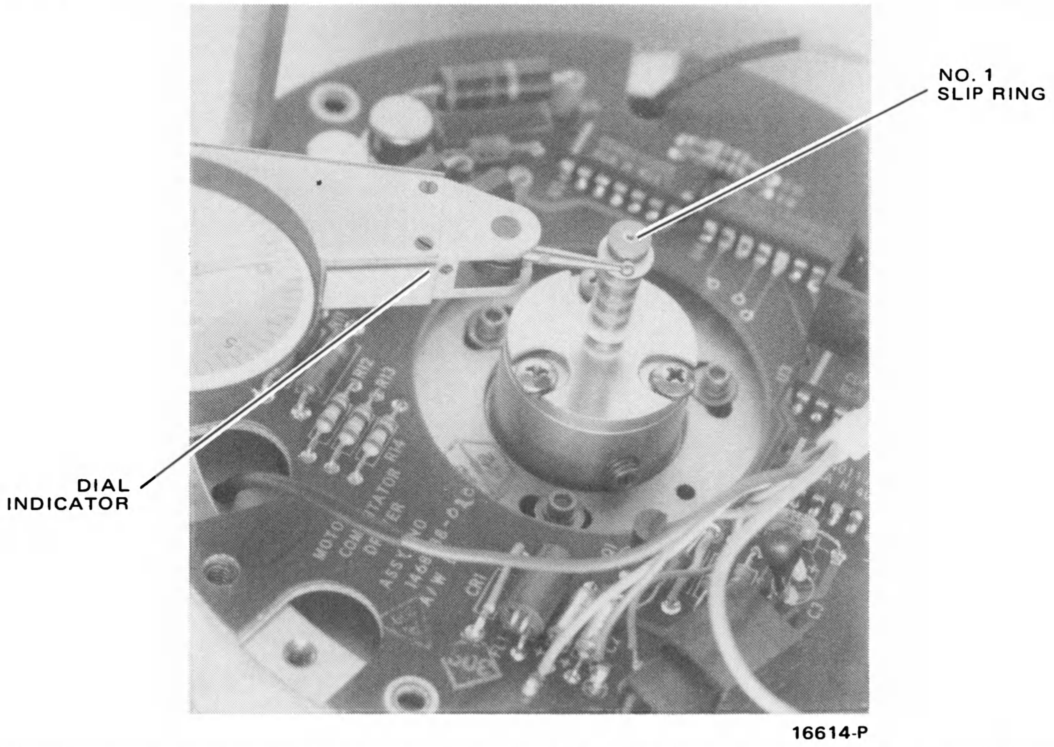


Figure 6-40. Measuring Scanner Slip-Ring Runout

STEP 25 Remove tubing used in step 8 (if present), and solder the six wires and braided ground strap to Preamplifier PWA, as shown in Figure 6-36. Use minimum amount of solder.

STEP 26 Reattach upper drum cover.

STEP 27 Replace scanner assembly into top plate of transport system.

6-41 Scanner Guide Replacement

The scanner guide assembly can be replaced on the VPR-3 without removing scanner assembly. Whenever guides are removed or their position changed, the interchange procedure (see paragraph 6-48) must be performed.

Proceed as follows, referring to Figure 6-41 as required:

STEP 1 Power off equipment.

STEP 2 Remove tape from transport.

STEP 3 Remove scanner guide covers and protective trim (see paragraph 6-27).

STEP 4 Rotate scanner so heads are away from guides.

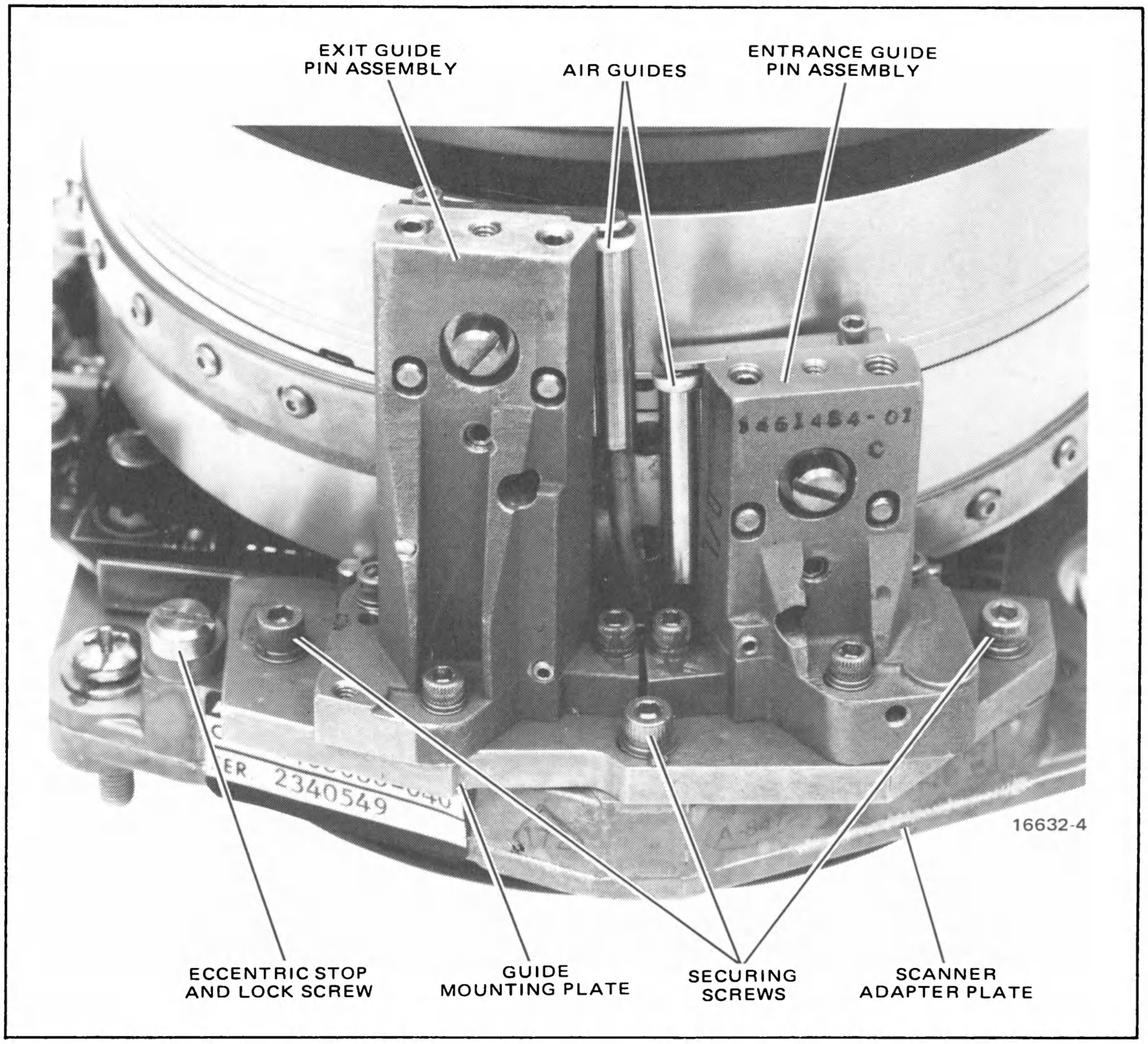


Figure 6-41. Scanner Guide Assembly Replacement

STEP 5 Remove 3 4-40 hex socket head cap screws securing guide mounting plate to scanner adapter.

It is recommended that the scanner guide assembly be left intact unless parts replacement is required. If guide assembly is disassembled, achieving correct interchange can become very difficult.

STEP 6 Replace with new scanner guide assembly, reversing steps 1 through 5.

STEP 7 Perform interchange procedure as required.

6-42 Scanner Motor Tach Pickup Assembly Replacement

Scanner motor tach pickup assembly is removed and replaced as follows:

STEP 1 Unfasten two cross-recessed screws and remove scanner motor cover.

STEP 2 Remove connector J2 from Motor Commutator PWA (see (A) in Figure 6-42).

STEP 3 Remove two optical tach clamps secured by four panhead screws. See (B) in Figure 6-42.

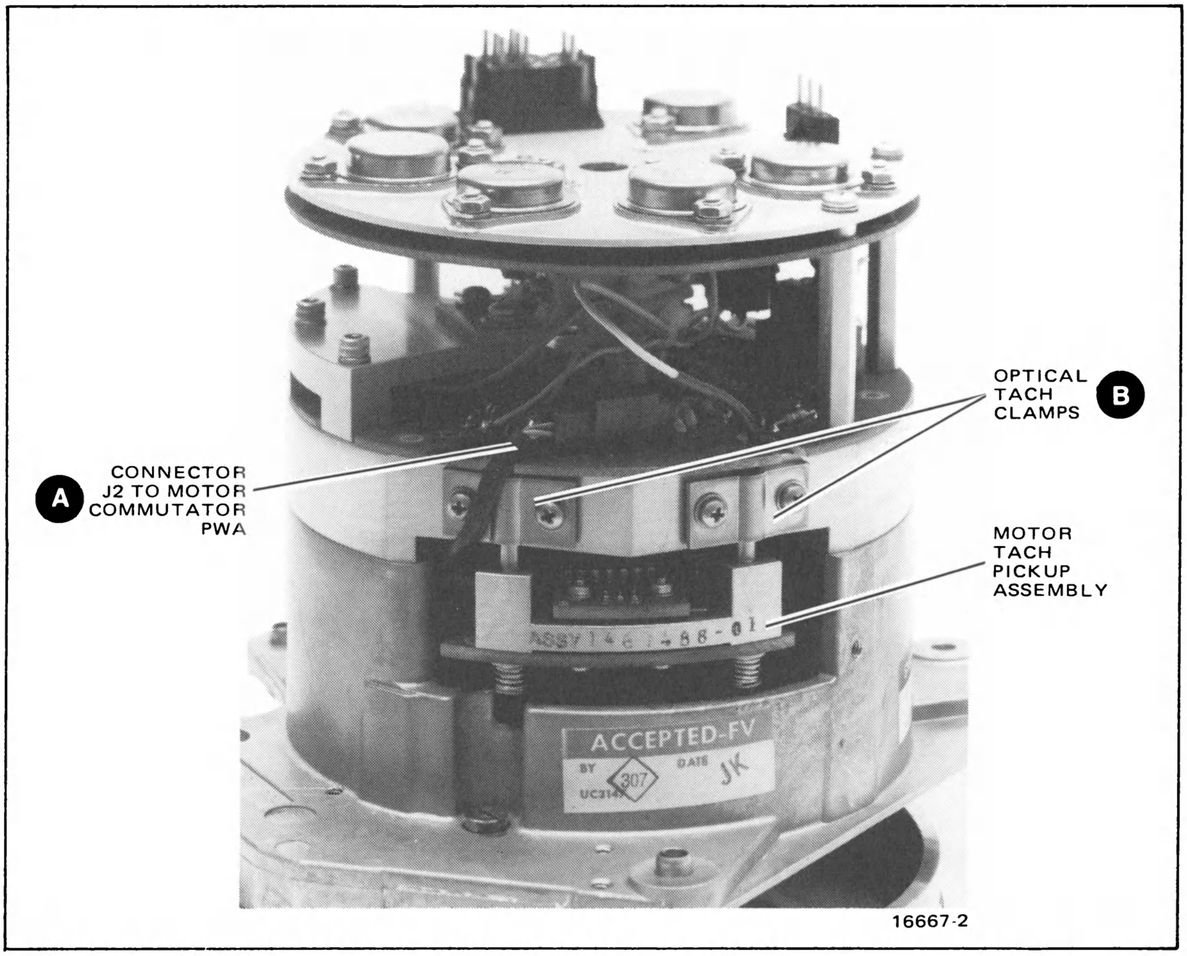

A
CONNECTOR J2 TO MOTOR COMMUTATOR PWA
B
OPTICAL TACH CLAMPS
MOTOR TACH PICKUP ASSEMBLY
ACCEPTED-FV
16667-2

Figure 6-42. Scanner Motor Tach Pickup Assembly Removal

STEP 4 Gently withdraw motor tach pickup assembly from side of scanner. Ensure that assembly does not contact optical tach disk as it is withdrawn.

STEP 5 To replace motor tach pickup assembly, reverse operations described in steps 1 through 4. Do not completely tighten screws securing optical tach clamps.

STEP 6 Insert two strips (approximately 2 inches long by 1/8-inch to 1/4-inch wide) of 0.0125-inch plastic shim stock between optical tach disk and

Motor Tach Sensor PWA. See Figure 6-43. *Do not use metal shims or metal feeler gauges.*

STEP 7 Position pickup assembly so that both shims can be moved between tach disk and Motor Tach Sensor PWA with slight resistance.

STEP 8 Tighten two screws securing tach clamp. Check that the spacing is between 0.010 inch and 0.015 inch, using shim stock. The 0.010-inch stock should fit into the space; the 0.015-inch stock should not fit. If necessary, repeat steps 5 and 6.

STEP 9 Replace motor cover removed in step 7, and reinstall scanner assembly into machine.

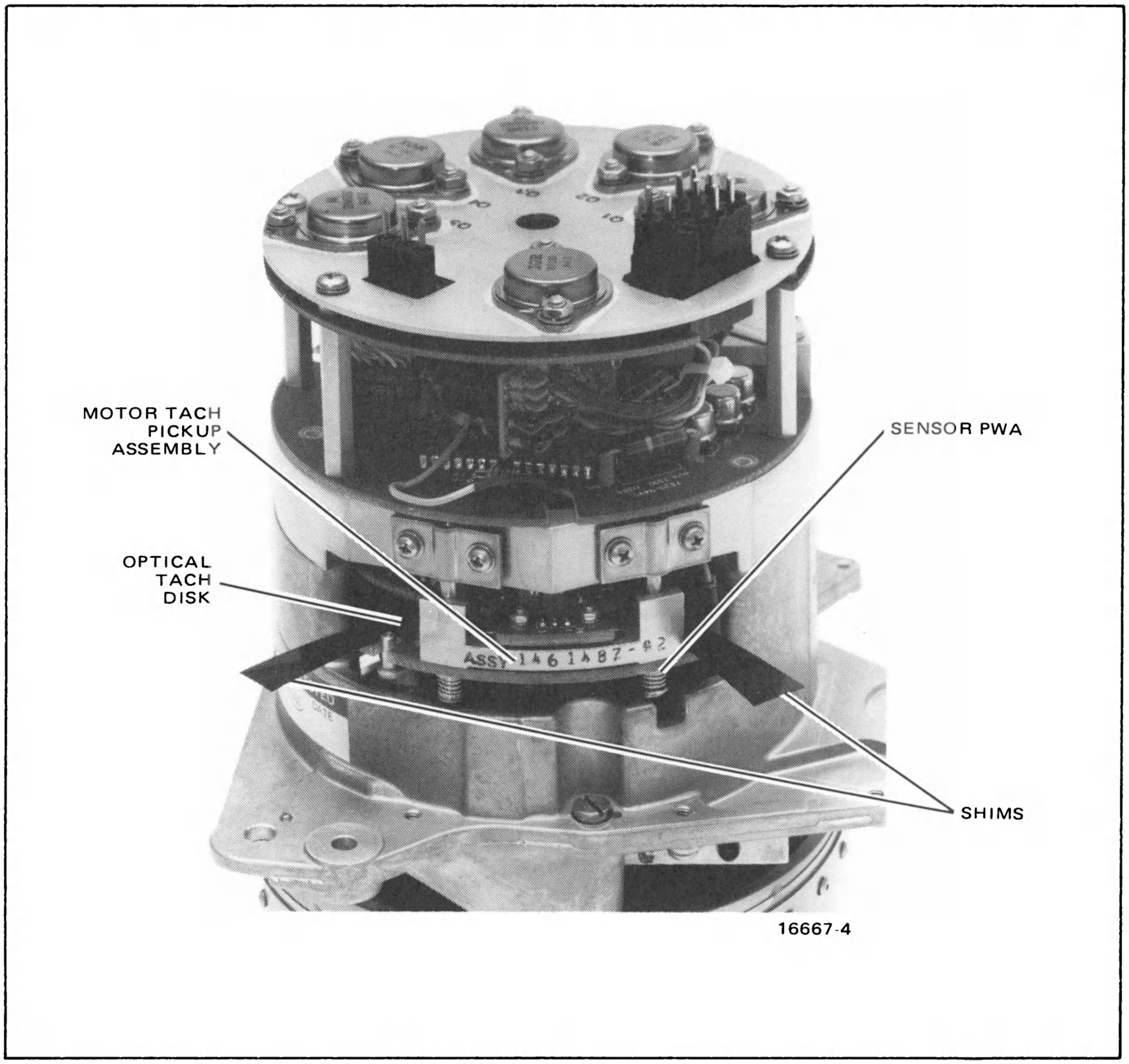


Figure 6-43. Scanner Motor Tach Pickup Assembly Shim Replacement

6-43 Scanner Once-Around Tach Pickup Assembly Replacement

Scanner once-around tach pickup assembly is removed and replaced as follows:

Note

Throughout this procedure, scanner must be prevented from rotating.

STEP 1 Unfasten cross-recessed screws and remove scanner motor cover.

STEP 2 Loosen lever holddown screw on tach adjustment assembly. See (A) in Figure 6-44.

STEP 3 Remove two optical tach clamps via four panhead screws. See (B) in Figure 6-44.

STEP 4 Use a slot-head screwdriver to slide serrated lever of tach adjustment assembly inward, causing tach adjustment arm to rotate clockwise and move scanner tach assembly (see (C) in Figure 6-44). Rotate arm a sufficient amount to free pickup assembly from tach adjustment arm post. See (D) in Figure 6-44.

STEP 5 Gently withdraw arm pickup assembly from scanner. Ensure that assembly does not come in contact with optical disk as it is removed.

STEP 6 Unsolder the four wires at terminals E1 through E4 on Scanner Tach Processor PWA. Remove assembly.

STEP 7 To install Scanner Tach Pickup Assembly, reverse operations performed in steps 5 and 6. Ensure that tach adjustment arm is returned to its slot in Scanner Tach Sensor PWA.

STEP 8 Replace optical tach clamps and four securing screws removed in step 2. Do not completely tighten securing screws.

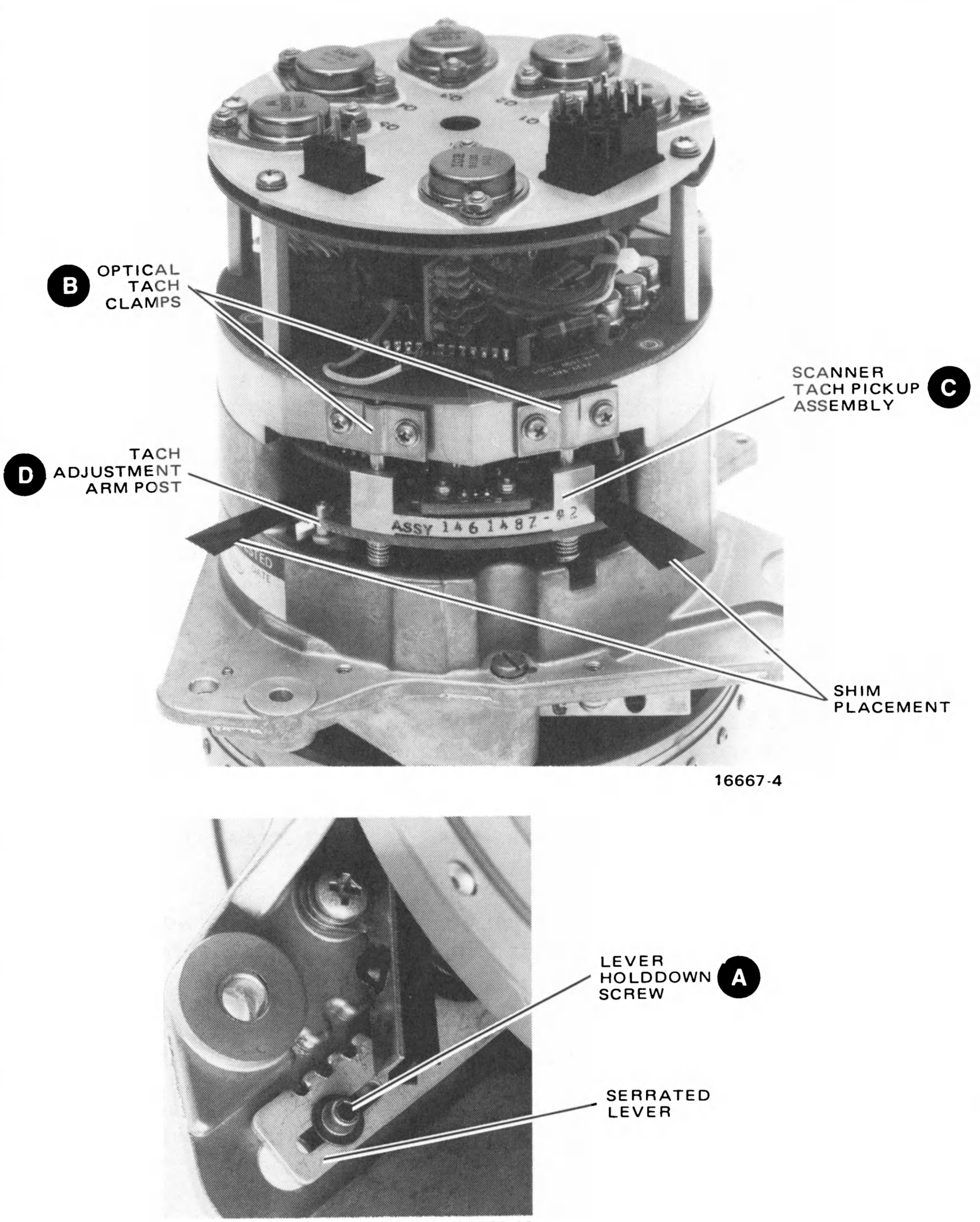
STEP 9 Insert two strips of 0.0125-inch plastic shim stock between optical tach disk and the Scanner Tach Sensor PWA. Refer to Figure 6-44 for shim placement.

STEP 10 Position pickup assembly so that both shims can be moved between tach disk and Scanner Tach Sensor PWA with slight resistance.

STEP 11 Tighten two screws securing tach clamp. Verify that spacing is between 0.010 inch and 0.015 inch; 0.010-inch shim stock should fit in space, while 0.015-inch shim stock should not go in. If necessary, repeat steps 9 and 10.

STEP 12 Replace motor cover removed in step 1, and reinstall scanner assembly into VTR..

STEP 13 Adjust scanner tach as described in interchange procedure (see paragraph 6-48).



TACH ADJUSTMENT ASSEMBLY

Figure 6-44. Scanner Once-Around Tach Pickup Assembly Removal

6-44 Scrape Flutter Idler Assembly Removal and Replacement

The scrape flutter idler assembly is removed as follows:

STEP 1 Remove protective trim as detailed in paragraph 6-27.

STEP 2 Remove connector J1 on flutter idler brake assembly (see (B) in Figure 6-45).

STEP 3 Remove two cross-recessed screws securing flutter idler assembly to top plate. Make sure "O" ring remains in place on top plate.

To remove brake assembly solenoid:

STEP 4 Remove hex screw securing brake bracket assembly to idler assembly base. See (A) in Figure 6-45.

STEP 5 Remove 2-56 nut securing solenoid shaft to brake arm.

STEP 6 Remove 4-40 pan-head cross-recessed screws securing solenoid plunger stop to bracket.

STEP 7 Remove cotter pin securing solenoid plunger to brake arm.

STEP 8 Remove nut securing solenoid to bracket and withdraw solenoid.

To replace flutter idler assembly, reverse steps 1 through 3 after reassembling brake assembly.

6-45 Shield Gate Assembly Removal and Replacement

The following procedure describes removal and replacement of the shield gate assembly, which improves the audio signal-to-noise ratio during normal operation.

STEP 1 Remove transport trim as described in paragraph 6-27.

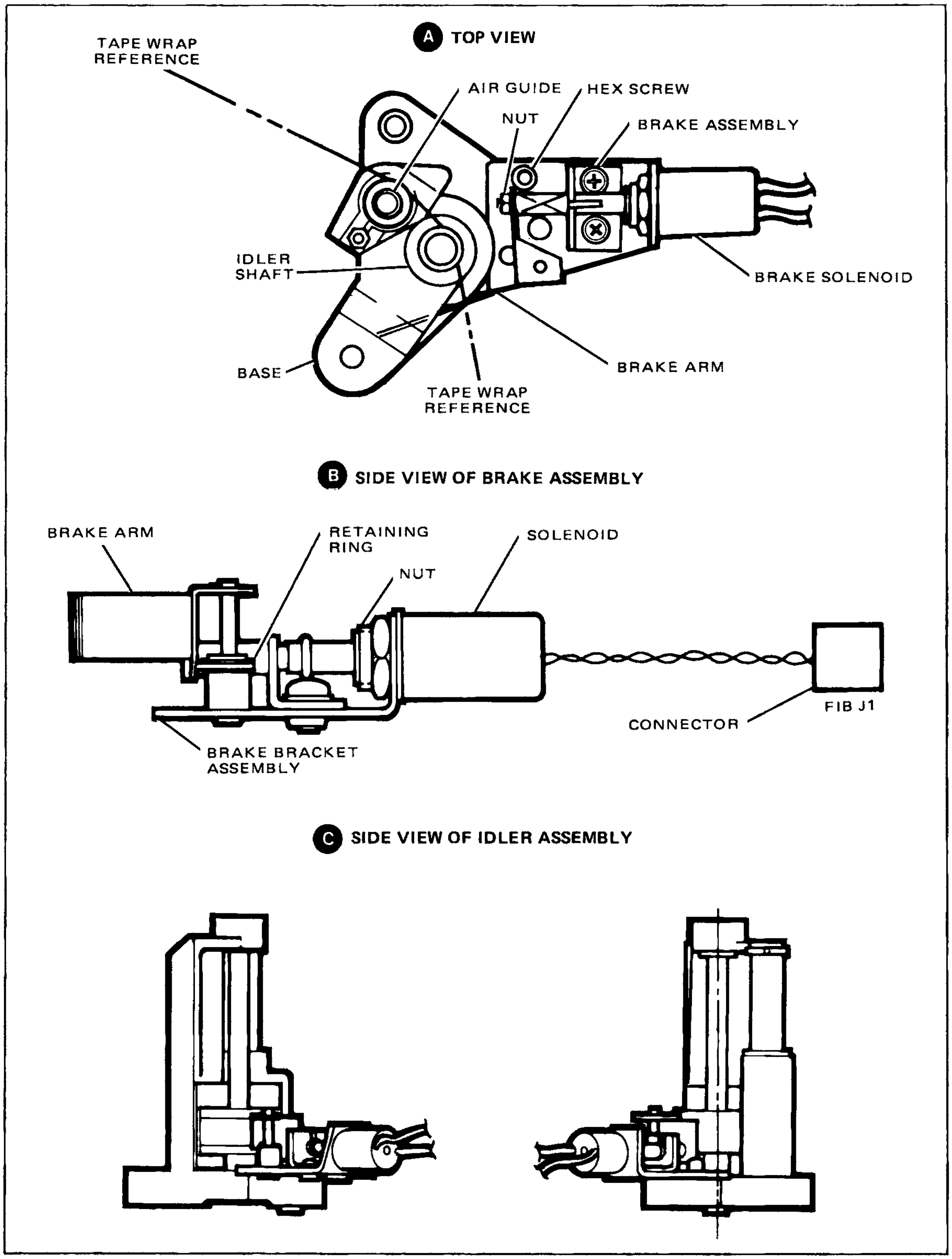
STEP 2 Remove cover on shield gate assembly (secured by either velcro or screws). See Figure 6-46 (A).

STEP 3 Remove two screws securing shield to gate thread block. See Figure 6-46 (B).

STEP 4 Remove air hose from fitting on shield gate assembly. See Figure 6-46 (C).

To replace shield gate assembly, reverse steps 1 through 4.

Figure 6-47 shows shield gate assembly side and top views.

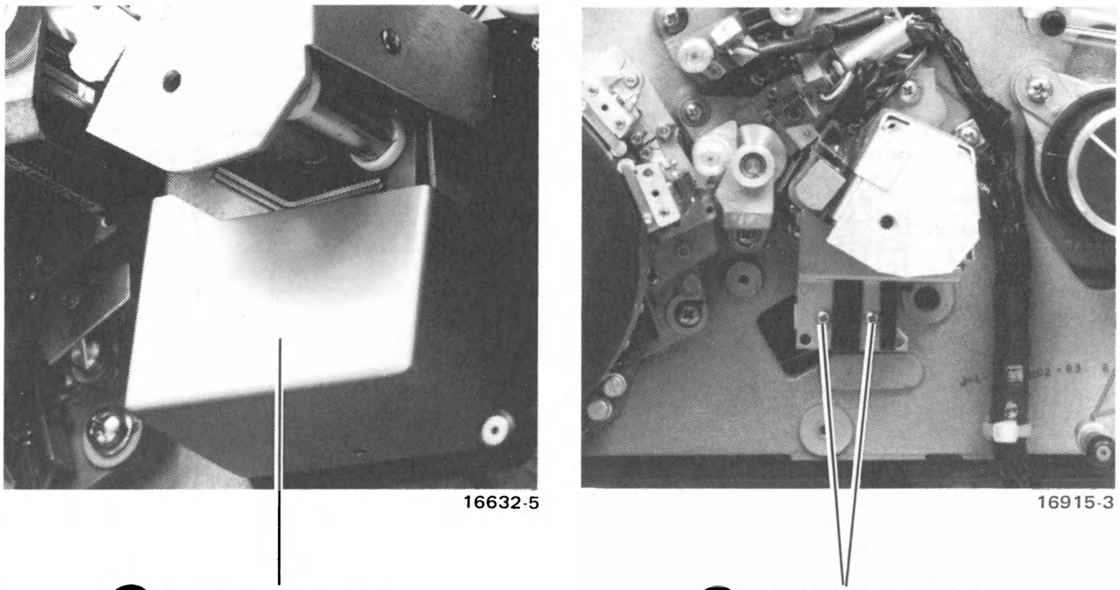


A TOP VIEW

B SIDE VIEW OF BRAKE ASSEMBLY

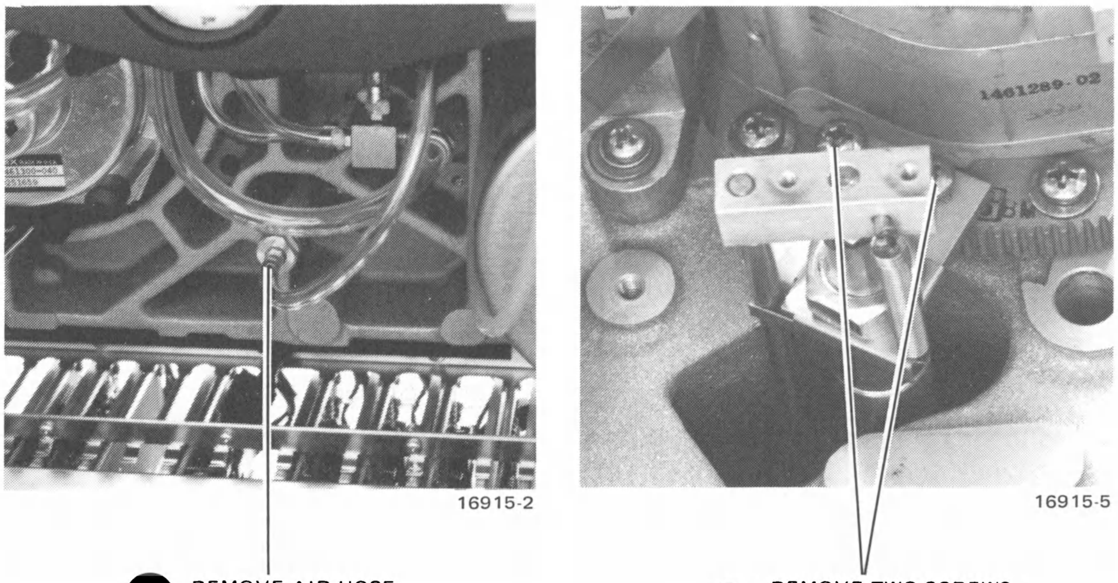
C SIDE VIEW OF IDLER ASSEMBLY

Figure 6-45. Scrape Flutter Idler Assembly Replacement



A REMOVE COVER ON SHIELD GATE ASSEMBLY

B REMOVE TWO SCREWS SECURING SHIELD



C REMOVE AIR HOSE FROM BACK

D REMOVE TWO SCREWS SECURING GATE CYLINDER SUPPORT

Figure 6-46. Shield Gate Assembly Removal

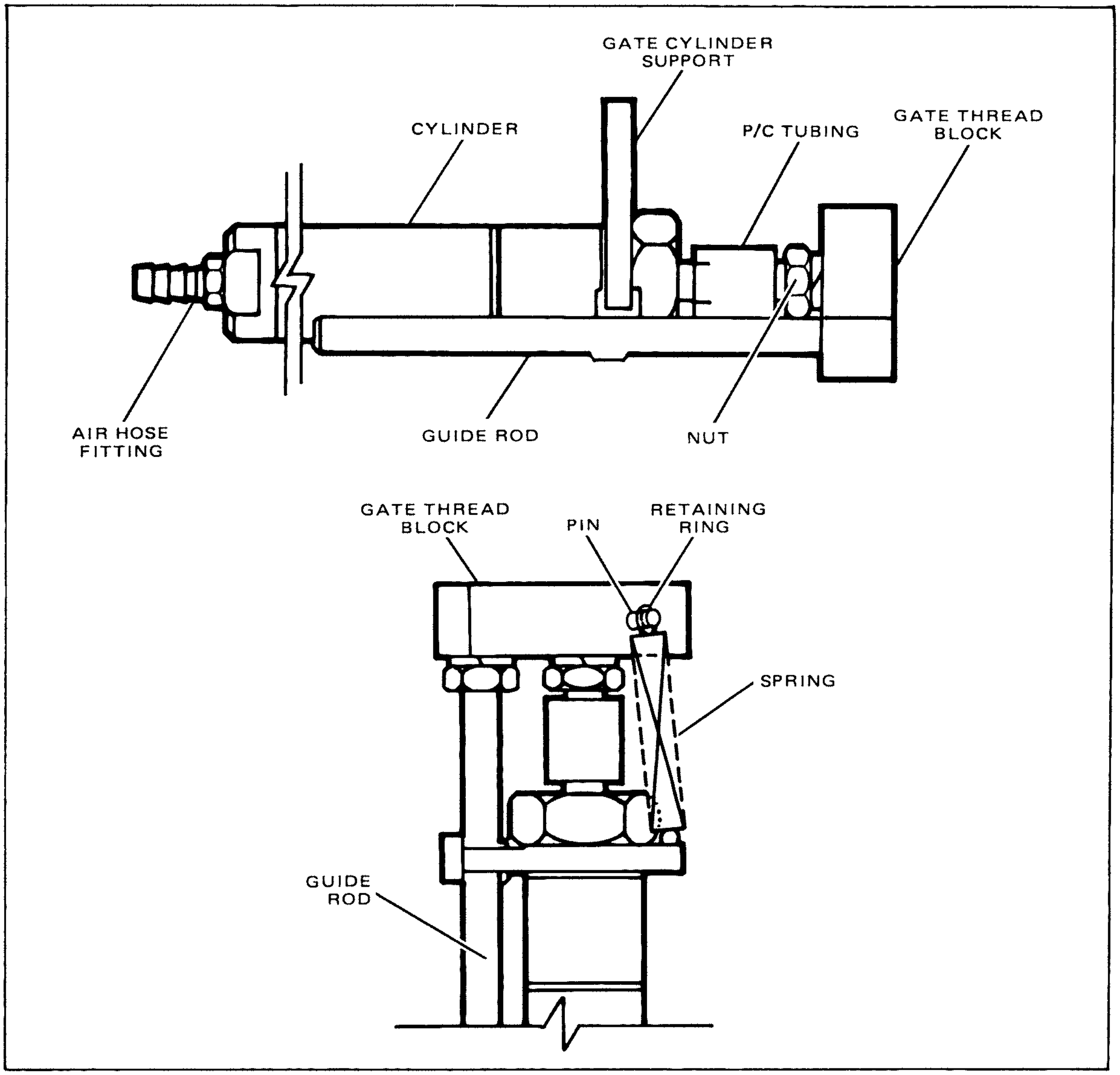


Figure 6-47. Shield Gate Assembly—Side and Top Views

6-46 Longitudinal Head Assembly Removal and Replacement

The following paragraph describes removal and replacement of the audio and control track longitudinal head assembly and head stacks for both 4-channel (P/N 1461280) and 3-channel (P/N 1461290) systems.

STEP 1 Remove transport trim as described in paragraph 6-27.

STEP 2 Remove shield gate assembly as described in paragraph 6-45.

STEP 3 Remove two screws securing audio head shield to base of longitudinal head assembly. See Figure 6-48 (A). Remove audio head shield.

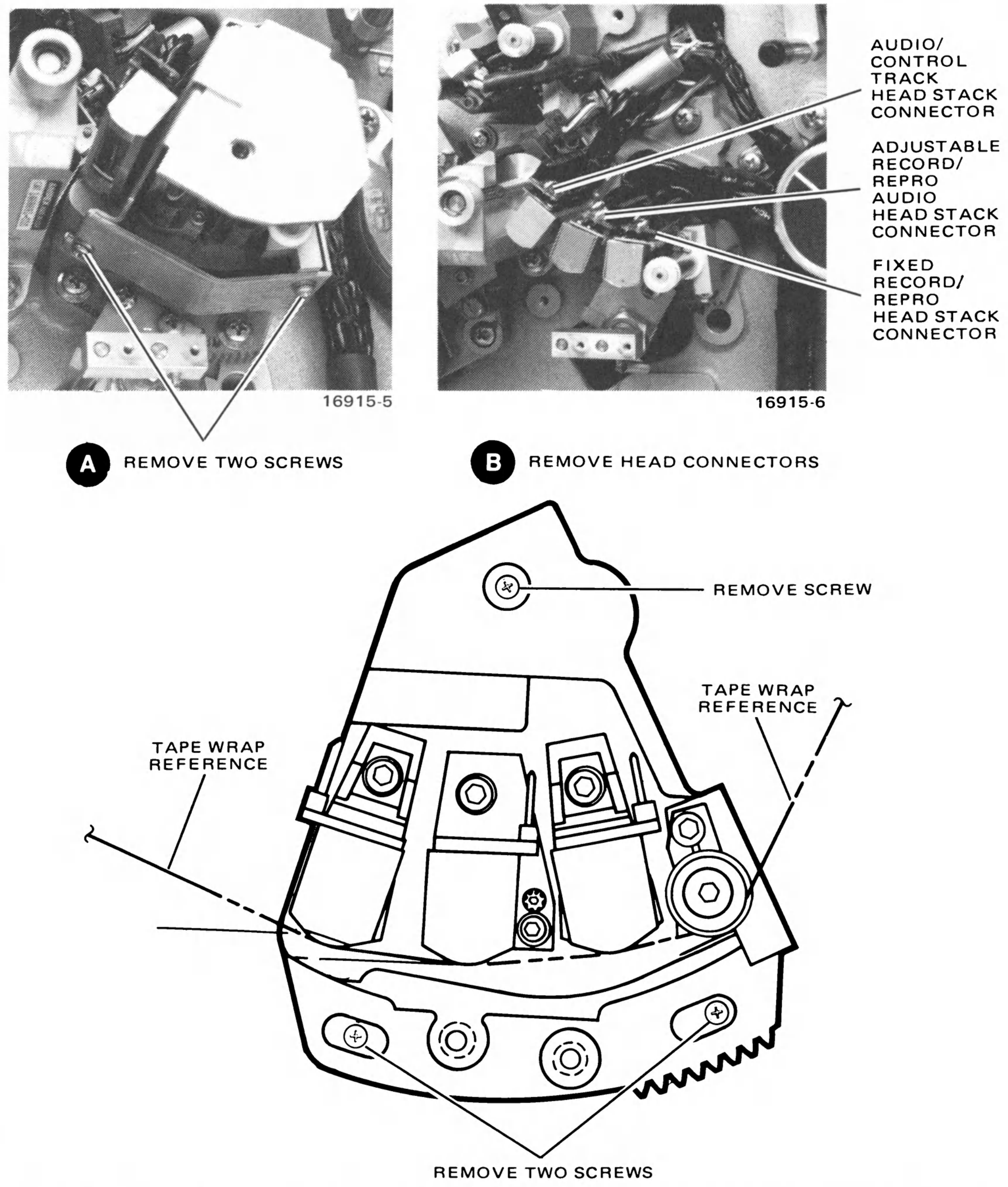

AUDIO/ CONTROL TRACK HEAD STACK CONNECTOR
ADJUSTABLE RECORD/ REPRO AUDIO HEAD STACK CONNECTOR
FIXED RECORD/ REPRO HEAD STACK CONNECTOR
16915-5
16915-6
A REMOVE TWO SCREWS
B REMOVE HEAD CONNECTORS
REMOVE SCREW
TAPE WRAP REFERENCE
TAPE WRAP REFERENCE
REMOVE TWO SCREWS

Figure 6-48. Longitudinal Head Assembly Removal

STEP 4 Carefully remove three head cable connectors. Do not pull on wires. Avoid bending connector pins. See Figure 6-48 (B).

STEP 5 Use a pencil to make alignment marks on longitudinal head assembly base and top plate in multiple locations at different angles for coarse reference when replacing assembly.

STEP 6 Remove 8-32 panhead cross-recessed screw at top of longitudinal head assembly base securing it to top plate. Remove 2 8-32 panhead cross-recessed screws securing base to top plate. Remove longitudinal head assembly. See Figure 6-48 (C). Make sure "O" ring in air passage remains in place on top plate.

To replace longitudinal head assembly, reverse steps 1 through 6, then perform interchange procedures as required.

6-47 Capstan Assembly Removal and Replacement

Two people are required to remove and replace the capstan assembly. Proceed as follows:

STEP 1 Turn off VPR-3 power.

STEP 2 Remove transport assembly protective trim. See paragraph 6-27.

STEP 3 Wrap capstan hub with a soft clean cloth and secure it to capstan hub.

STEP 4 Open rear panel of VPR-3 and lower power supply to gain access to components on back side of top plate.

STEP 5 Remove two electrical plugs from connectors on rear of capstan assembly. See Figure 6-49.

STEP 6 Remove vacuum line from connector on capstan. See (A) in Figure 6-50.
STEP 7 Remove nut (see (B) in Figure 6-50) securing takeup tension arm air dashpot, and carefully remove air dashpot (see (C) in Figure 6-50).

STEP 8 While one person holds the capstan assembly from rear of transport, loosen and remove two screws securing capstan assembly to transport top plate. See (D) in Figure 6-50.

STEP 9 Push capstan assembly forward about 1/8-inch until locators in capstan assembly's mounting holes clear transport top plate. Then rotate capstan assembly about 45 degrees until assembly's mounting flanges clear transport top plate when capstan assembly is withdrawn from plate.

CAUTION

DO NOT ALLOW CAPSTAN HUB TO STRIKE THE TOP PLATE AS IT IS DRAWN THROUGH MOUNTING HOLE IN TOP PLATE. THIS CAN DAMAGE CAPSTAN HUB.

STEP 10 Carefully withdraw capstan assembly from bottom of transport top plate. Do not allow capstan hub to strike top plate as it passes through mounting hole.

STEP 11 Untie and remove cloth from capstan hub.

STEP 12 Capstan assembly can be replaced on transport top plate using above steps in reverse order.

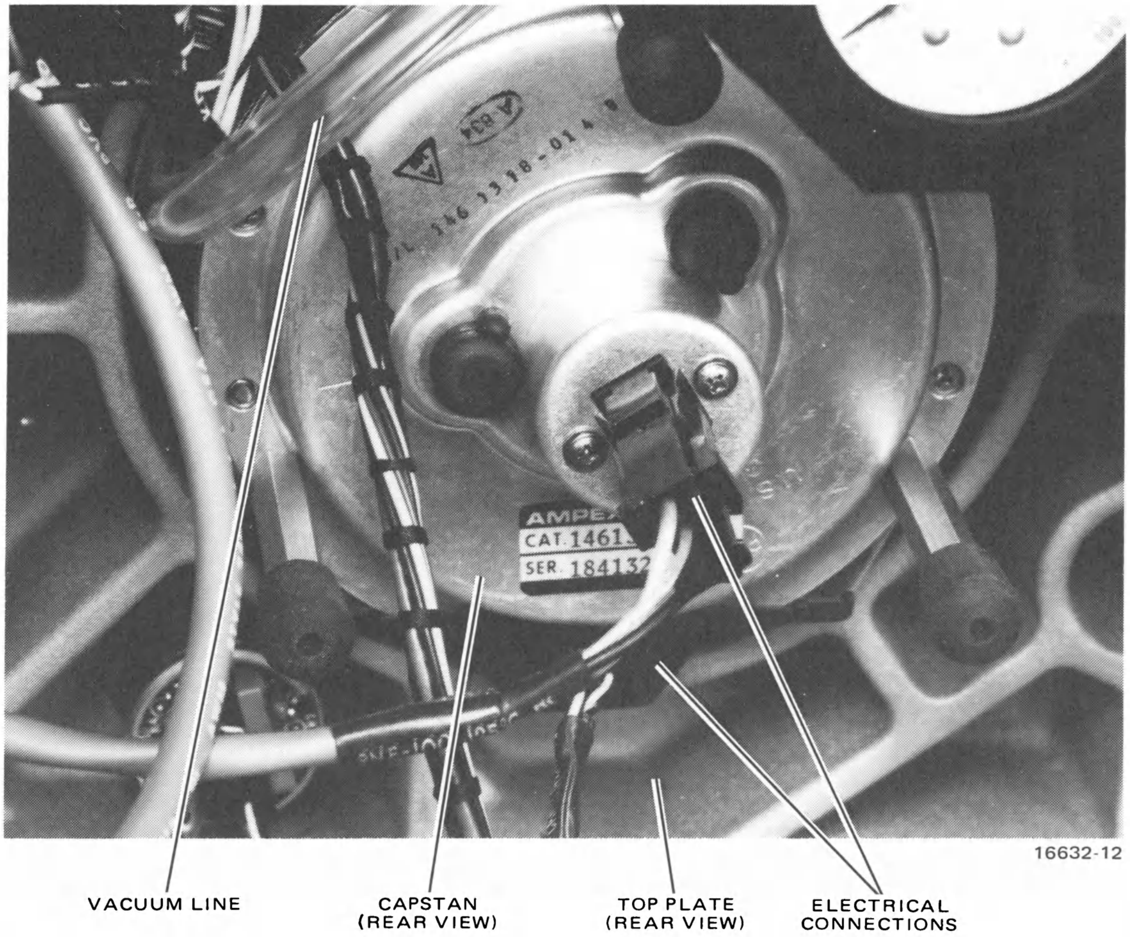


Figure 6-49. Capstan Assembly — Rear View

6-48 INTERCHANGE PROCEDURES

The following paragraphs detail the interchange procedure used to ensure compatibility of recorded material among different C-Type VTRs. This procedure, or pertinent parts of it, should be performed whenever the transport system alignment has been affected (such as replacement of parts, etc.).

6-49 General

To assure tape interchangeability among C-type machines, all VPR-3s are calibrated at the factory to uniform tape guiding and tracking parameters. These parameters must be checked, and adjusted as necessary, whenever tape transport system components are moved or replaced. Alignment of the transport system is referred to as the "interchange procedure."

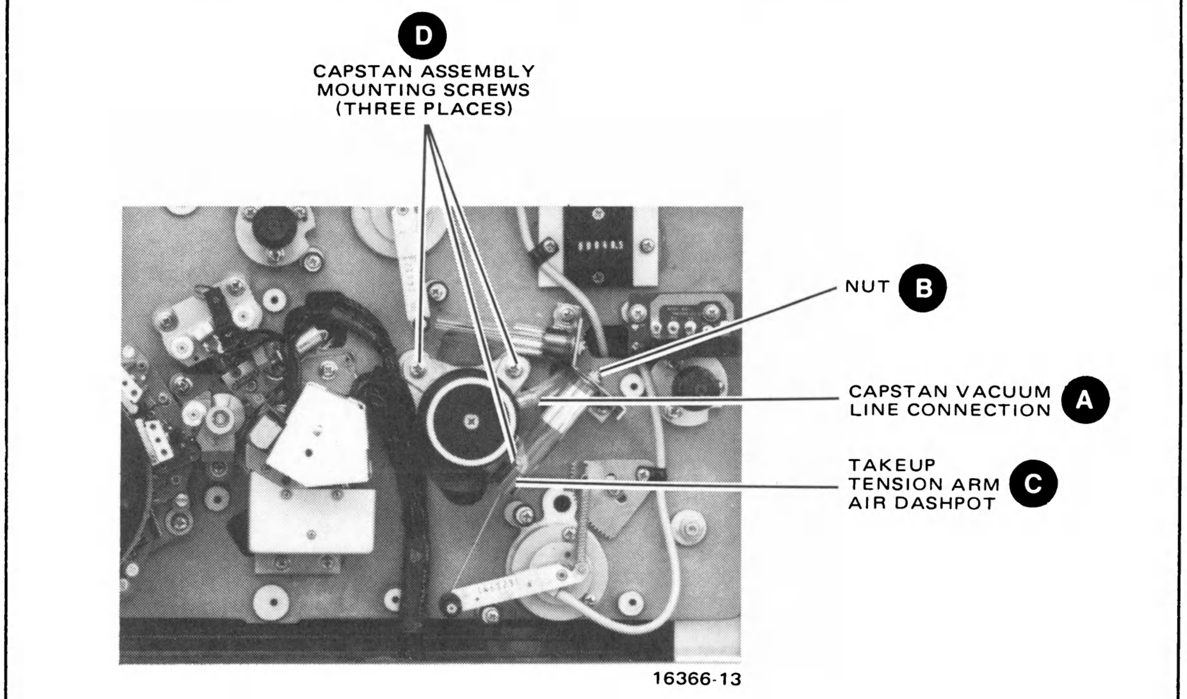

D
CAPSTAN ASSEMBLY MOUNTING SCREWS (THREE PLACES)
NUT B
CAPSTAN VACUUM LINE CONNECTION A
TAKEUP TENSION ARM AIR DASHPOT C
16366-13

Figure 6-50. Capstan Assembly Removal From Transport Top Plate

The interchange procedure is comprised of a number of operations that should be performed in the following order:

- Tape tension adjustments
- Track straightness adjustment
- Scanner once-around tach adjustment
- Head tip projection measurement
- Helical scan dropout duration and position adjustments
- Control track position adjustments.

Figure 6-51 shows locations of these adjustment and measurement operations.

Service personnel performing these adjustments should read and understand all procedures thoroughly before attempting to perform any adjustment. Be sure to take all precautions noted in the procedures.

Type-C 1-inch helical VTRs must meet certain standards of precision in helical adjustment to assure tape compatibility. A key element is the uniformity of the helical path described by the video head as it scans the tape. On the VPR-3, the helical path is determined primarily by the factory-set helical guide band on the lower scanner, but is also affected by adjustable entrance and exit guides. These guides influence position and attitude of tape as it begins and ends its wrap around the scanner. Helical alignment is checked by comparing video head tracking to the tracking standard provided on a guide alignment tape (refer to Table 1-3 for correct alignment tape type).

The rf envelope (as seen on an oscilloscope) provides a visual method of observing video head tracking. Figure 6-52 shows an example of an rf envelope with ideal interchange alignment. Figure 6-53 shows examples of rf envelopes produced by improper interchange alignment.

Incorrect alignment of the entrance and exit guides to the scanner can also cause inaccurate dropout position and width.

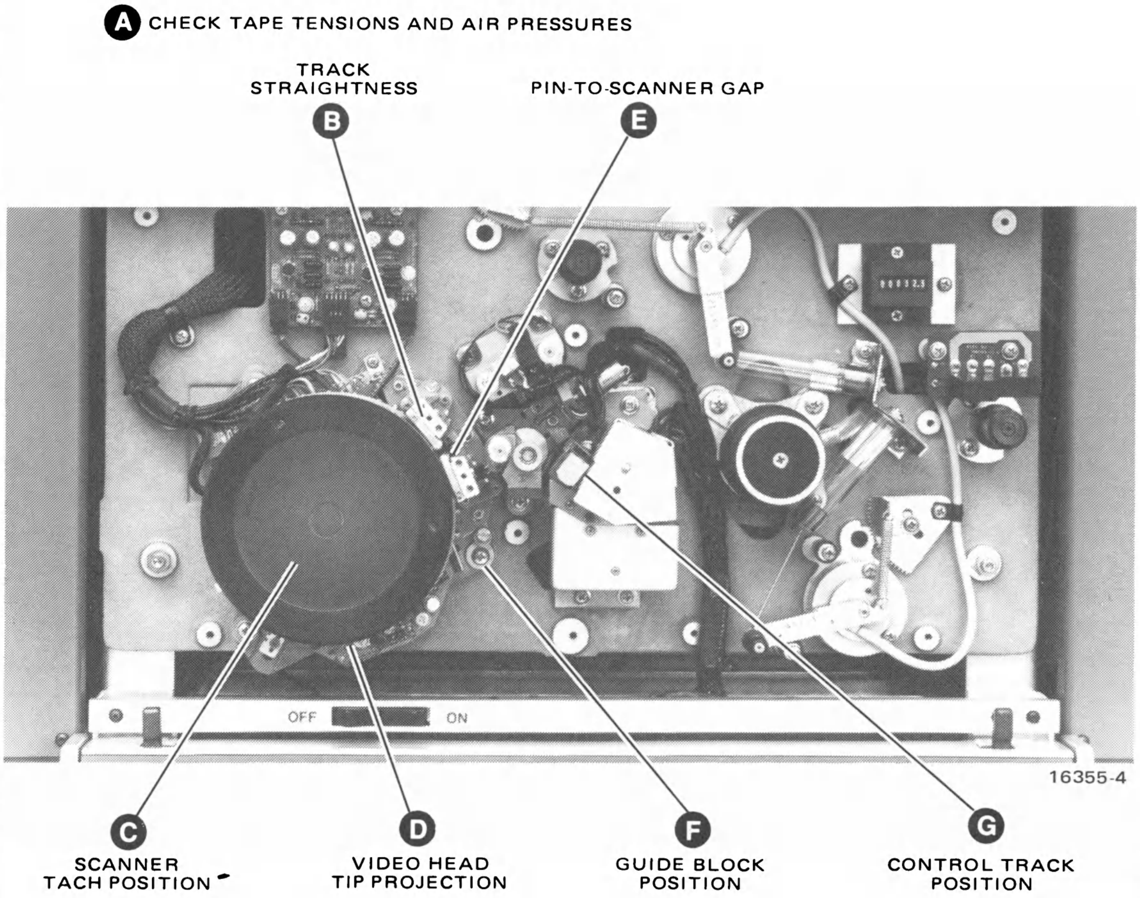


Figure 6-51. Interchange Procedure Operations

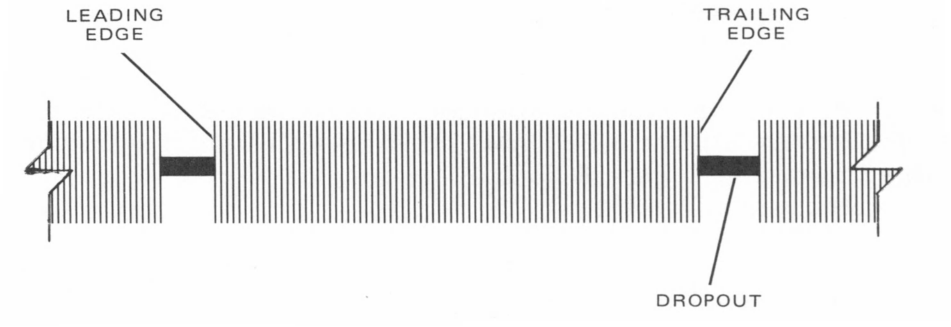


Figure 6-52. Ideal Interchange RF Envelope

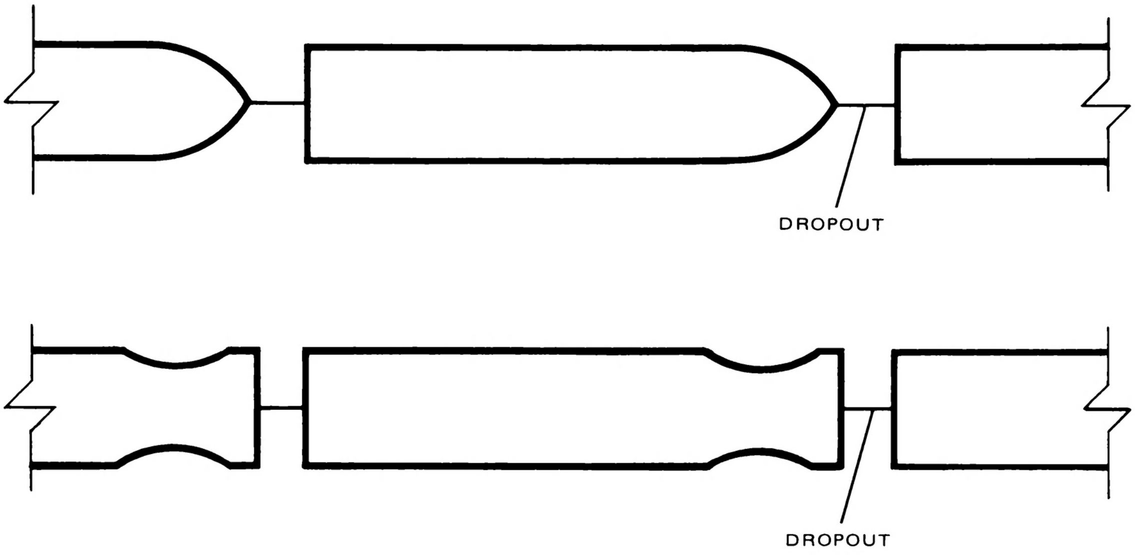


Figure 6-53. Examples of Improper Interchange RF Envelopes

6-50 VPR-3 Interchange Procedure Setup

The VPR-3 should be set up to simulate record timing for interchange tests. Upon completion of tests and adjustments, the VPR-3 should be returned to normal operation setup. The following setup changes for interchange are:

- On Playback Sync Processor PWA 6 set REGEN SYNC INSERT switch S1 and SYNC CHAN P/B switch S2 to OFF position.
- Press **setup** soft key in the HOME menu to call Setup Select menu.
- Press **video** soft key to call Video Setup menu.

Press **pb hd** in Video Setup menu to select record head for playback—**record** is displayed in field above **pb hd** label.

CAUTION

WHEN THREADING ANY ALIGNMENT TAPE ON THE VPR-3, SET REC LOCKOUT SWITCH (S1) ON FRONT OF CONTROL PWA 20 TO ON.

6-51 VPR-3 Transport System Checks and Adjustments

The following checks and adjustments should be made on the VPR-3 transport system.

Check and adjust tape tension and capstan current (which is an accurate indication of tape tension) as follows:

STEP 1 Thoroughly clean all components in tape path. Xylene or Ampex Head Cleaner is recommended for all record, playback, and erase heads, metal guides, and scanner surface.

STEP 2 Demagnetize all tape path components.

STEP 3 Check entrance and exit guide air pressure, scanner air pressure and air flow, and capstan vacuum. Nominal values are:

- Transport guide air pressure: 5.0 psi.
- Scanner guide air pressure: 7.5 psi.
- Scanner air flow: 1.0 to 1.25 SCFH
- Capstan vacuum: 70 inches

Refer to paragraph 9-12 for air system adjustment procedures.

STEP 4 Remove transport trim before starting tape tension checks, as detailed in paragraph 6-27. Check calibration of tape tension gauge (values listed are for a fixed-pin type of Tentelometer; rotating-pin type gauges will be approximately 0.5 oz less).

STEP 5 Check tape tensions for the following nominal values:

a. Between supply tension arm and longitudinal erase head—approximately 6.0 oz.

b. Between longitudinal erase head and scanner entrance guide—approximately 6.5 oz.

c. Between scanner exit guide and flutter idler assembly—approximately 8.0 oz.

d. Between longitudinal audio head assembly and vacuum capstan—less than 9.0 oz.

e. Between vacuum capstan and takeup tension arm—approximately 7.0 oz.

f. Between takeup tension arm and takeup reel—approximately 6.5 oz.

STEP 6 Check capstan current, as shown in the diagnostics menu. From the HOME menu, press **diag** soft key, then press **servo** soft key. The capstan current should be 0.9 amps or less, as shown above the **cap** soft key. Check also for equal (but opposite signs) currents in 1X play speed forward and 1X play speed reverse in the variable play mode.

STEP 7 Tape tension at the takeup and supply tension arms can be adjusted in this manner: slightly loosen the 8-32 pan-head cross-recessed screw securing the spring anchor (plate with serrated base). Use a flat blade screwdriver of appropriate width to engage teeth on serrated plate. Clockwise movement reduces tape tension; counterclockwise rotation increases tape tension. Tighten screw securing plate when adjustment is complete.

If capstan current is too high, check air guides for clogging. Also examine tape edges at scanner entrance and exit guides for distortion. Examine the rf envelope for smoothness, as described in paragraph 6-49.

6-52 Video Track Straightness Measurement and Adjustment

This adjustment procedure optimizes rf envelope symmetry. Track straightness is indicated when envelope is as rectangular as possible, and when breathing, undulations, and fluctuations do not exceed 10% of envelope amplitude. Track straightness is checked by playing back the guide alignment tape, and adjusting tracking manually while observing the rf envelope. Determine video track straightness, and adjust as follows, if necessary:

STEP 1 Connect channel 1 of scope to TP13 of Mod/Demod PWA 1. Trigger scope from TP4 on Playback Sync Processor PWA 6.

STEP 2 Press rf on monitor select section of control panel.

STEP 3 Press UNITY/VAR indicator to illuminate VAR.

STEP 4 From HOME menu, press **setup** to call Setup Select menu.

Press **servo** to call Servo Setup menu.

Press **trkng** to select variable tracking.

This gives shuttle control knob control of tracking. Note that tracking is automatically returned to Unity (shuttle control knob will not control tracking) whenever tape is unthreaded from transport. A tape-in-transport sensor, located in the video erase head assembly, detects tape unthreading.

STEP 5 Play back guide alignment tape.

STEP 6 Rotate tracking control knob (shuttle control knob) back and forth slowly while observing rf envelope. As knob is turned past the point of maximum rf, envelope should collapse evenly, with no wavering around edges at dropout area or through envelope. See Figure 6-54. If rf envelope collapses unevenly, tape is not aligned properly around drum.

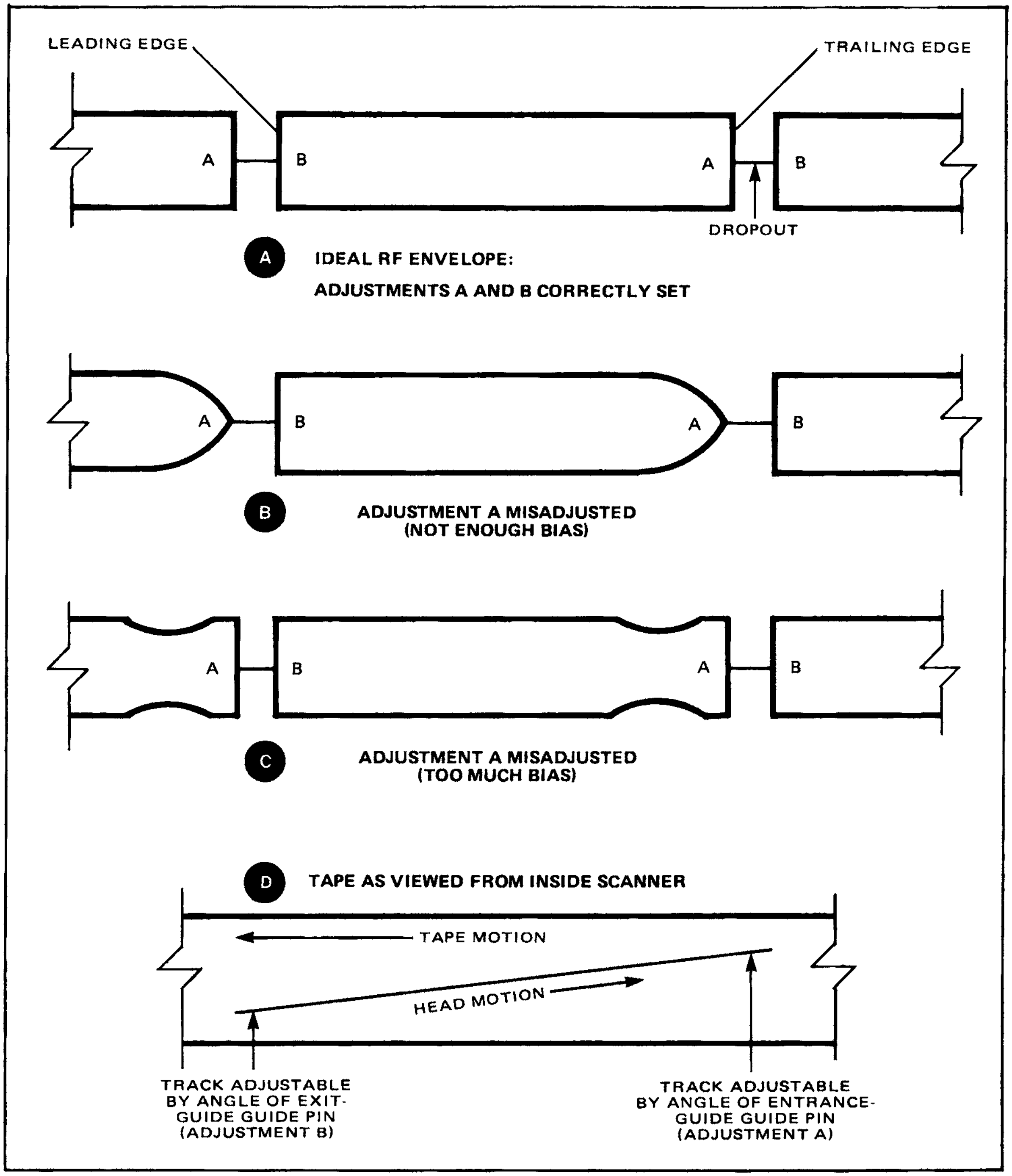

LEADING EDGE
TRAILING EDGE
A
B
A
B
DROPOUT
A IDEAL RF ENVELOPE:
ADJUSTMENTS A AND B CORRECTLY SET
A
B
A
B
B ADJUSTMENT A MISADJUSTED
(NOT ENOUGH BIAS)
A
B
A
B
C ADJUSTMENT A MISADJUSTED
(TOO MUCH BIAS)
D TAPE AS VIEWED FROM INSIDE SCANNER
TAPE MOTION
HEAD MOTION
TRACK ADJUSTABLE BY ANGLE OF EXIT-GUIDE GUIDE PIN (ADJUSTMENT B)
TRACK ADJUSTABLE BY ANGLE OF ENTRANCE-GUIDE GUIDE PIN (ADJUSTMENT A)

Figure 6-54. Effects of Helical Alignment Adjustment on RF Envelope

STEP 7 Adjust tracking control to peak up rf display on scope.

STEP 8 If observations made while performing step 4 indicate improper tape alignment around drum, adjust guides in accordance with steps 9 through 11.

Note

Guide position is optically set in factory. Adjustments should not require more than 1/8 turn of screws in either direction.

CAUTION

USE EXTREME CARE IN MAKING ANY GUIDE ADJUSTMENTS. GUIDE HEIGHT AND GUIDE ANGLE ADJUSTMENTS ARE INTERACTIVE, AND ARE ADJUSTED TOGETHER IN SMALL INCREMENTS TO ACHIEVE CORRECT BIASING OF TAPE ONTO GUIDE BAND AND A FLAT RF ENVELOPE AS TRACKING IS VARIED. MISADJUSTMENT CAN CAUSE SERIOUS INTERCHANGE PROBLEMS.

STEP 9 Loosen slotted guide adjustment locking screws on entrance and exit guides one-quarter turn. See Figure 6-55.

STEP 10 Adjust entry height adjustment screw C for proper tape biasing by the ceramic edge guide. (Edge guide should not buckle tape, while a push on the entry keeper should cause a dip of not more than 10% in the right edge of the rf envelope). Be careful not to push ceramic guide into rotating scanner. A clockwise turn on screw C will increase bias on tape, while a counterclockwise turn will raise edge off the tape.

Alternate this height adjustment with adjustment of screw A (angle adjust) to peak up rf envelope on right side of dropout without causing a dip in rest of envelope. Turning screws in the same direction and the same amount is generally required to correctly adjust the guides.

STEP 11 Repeat procedure above with screws B (angle) and D (height) for exit guide.

STEP 12 Adjust tracking, and verify that rf envelope rises and falls uniformly on scope. A push on entrance and exit guide keeper should cause a slight dip on rf envelope edge. (Make sure tape is not being buckled by ceramic edge guide.) Adjust screws C and D if necessary. Fine adjust screws A and B to obtain uniform rf envelope.

STEP 13 Press STOP. When scanner stops, tighten slotted screws on entrance and exit guides on scanner.

STEP 14 Place VTR in play mode and check that rf envelope still rises and falls evenly as tracking is varied. Repeat adjustment of screws A and B (as described in steps 9 through 13 above) if necessary.

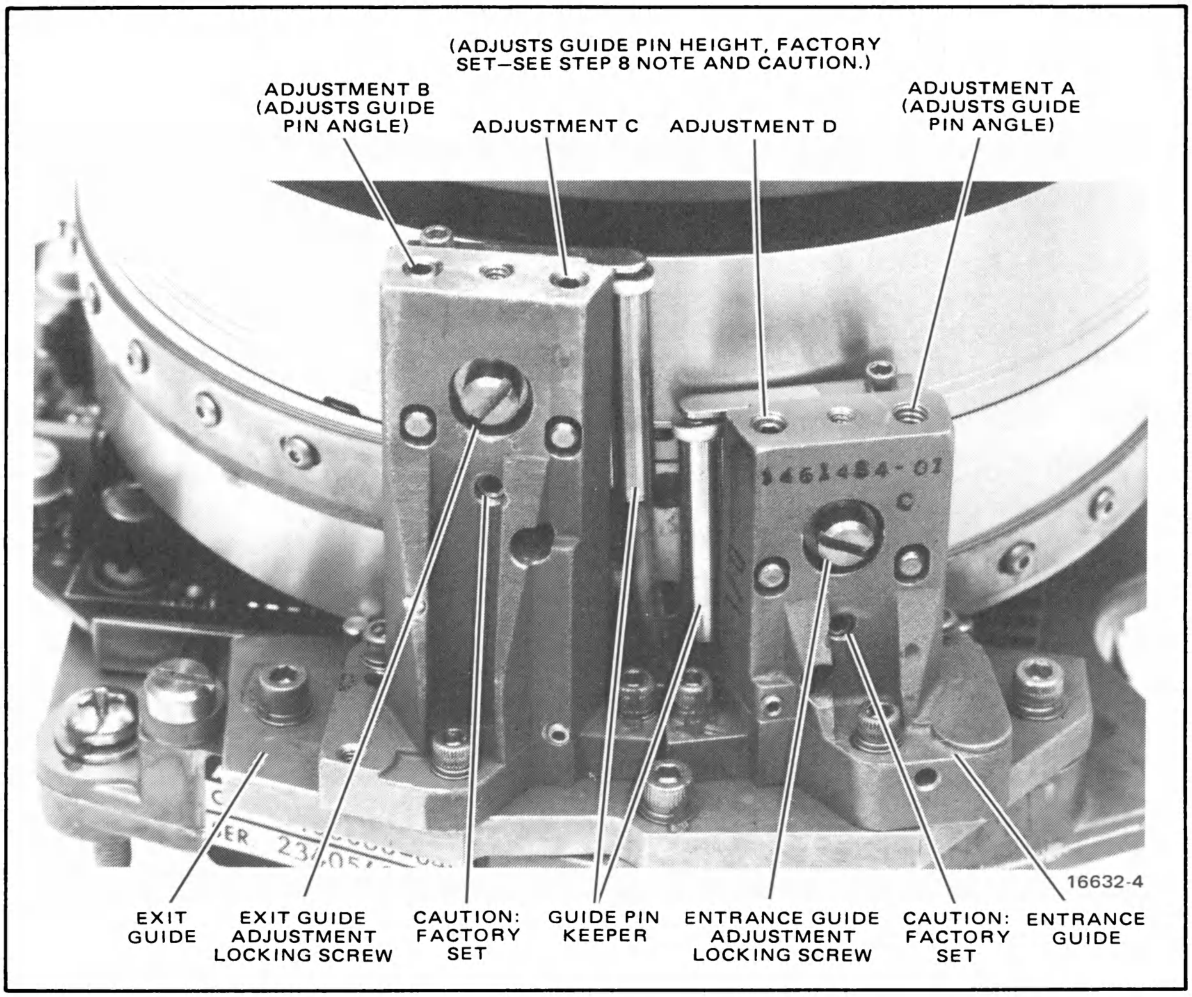

(ADJUSTS GUIDE PIN HEIGHT, FACTORY SET—SEE STEP 8 NOTE AND CAUTION.)
ADJUSTMENT B (ADJUSTS GUIDE PIN ANGLE)
ADJUSTMENT C
ADJUSTMENT D
ADJUSTMENT A (ADJUSTS GUIDE PIN ANGLE)
16632-4
EXIT GUIDE
EXIT GUIDE ADJUSTMENT LOCKING SCREW
CAUTION: FACTORY SET
GUIDE PIN KEEPER
ENTRANCE GUIDE ADJUSTMENT LOCKING SCREW
CAUTION: FACTORY SET
ENTRANCE GUIDE

Figure 6-55. Scanner Assembly Entrance and Exit Guides Adjustment

6-53 Scanner Once-Around Tach Position Check and Adjustment

Position of scanner once-around tach determines height of video track recordings. This position has been set at the factory, and should not require adjustment. However, if scanner has been disassembled, or if VTR is making recordings with errors in dropout position, then tach position should be verified before making further adjustments. Check and adjust scanner tach position as follows:

STEP 1 Connect channel 1 probe of oscilloscope to TP13 of Mod/Demod PWA 1. Trigger oscilloscope from WAVEFORM MONITOR SYNC line on rear connector panel of VPR (use a BNC T-connector).

STEP 2 From HOME menu, press **assemble** to select assemble edit mode.

Press **setup** to call Setup Select menu.

Press **video** to call Video Setup menu.

Press **pb hd** to select record head for playback.

STEP 3 Set MASTER RECORD LOCKOUT switch S1 on Control PWA 20 to ON position (master record lockout on). The red RECORD LOCKOUT indicator on the operator control panel should be lit.

STEP 4 Press DEMOD VIDEO on the VPR-3 control panel and play back master guide alignment tape.

STEP 5 With VPR in variable tracking mode, carefully adjust tracking to peak the playback level as observed on the VIDEO/RF meter on the VPR-3 control panel. Improper tracking adjustment can introduce errors in scanner tach positioning.

Note

To ensure that you have not inadvertently loaded tach phase into software memory, perform a "first birthday." This will cancel previous tach position information and allow proper setup of record phase and dropout position.

STEP 6 Perform a "first birthday" as follows:
Press pushbutton S2 (control system reset switch) on the Control PWA 20 while simultaneously pushing VIDEO IN and AUDIO monitor switches on the operator control panel.

CAUTION

THIS WILL ERASE TAPE SETUP INFORMATION AND ALL PARAMETERS STORED IN MEMORY.

STEP 7 Momentarily press EE OVERRIDE on front of Equalizer PWA 3 and adjust oscilloscope to place the start of EE (reference video) vertical broad pulse on a convenient graticule marking.

STEP 8 Release EE OVERRIDE switch and observe that vertical sync edge of demod video is coincident ±1 microsecond with reference vertical. See Figure 6-56. If it is not, loosen lever lock-down screw and use a screwdriver to move serrated lever for coincidence of the vertical timing edges 1 microsecond. See Figure 6-57.

STEP 9 Observe horizontal pulses after dropout (approximately line 17-20 on NTSC). If necessary, adjust for coincidence ±1 microsecond.

STEP 10 Tighten lockdown screw. Observe that there is no change in timing when screw is tightened.

6-54 Helical Scan Dropout

Helical scan dropout begins when rotating video record head leaves the tape near the scanner entrance guide and ends as head begins its scan on tape just past exit guide. Dropout duration is factory-set (by placement of guides on the scanner guide

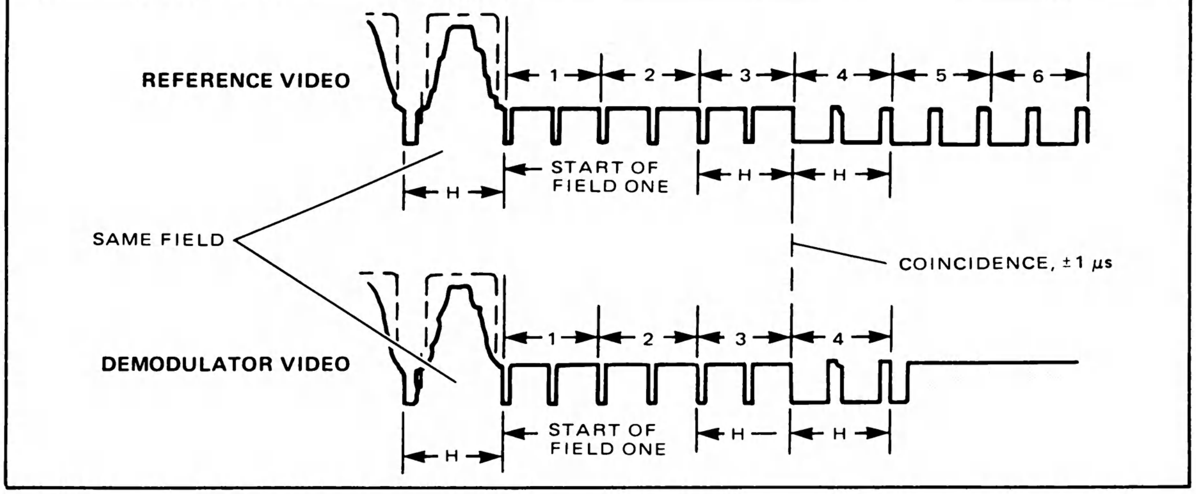


Figure 6-56. Reference Video Signal Coincidence with Demodulator Video Signal

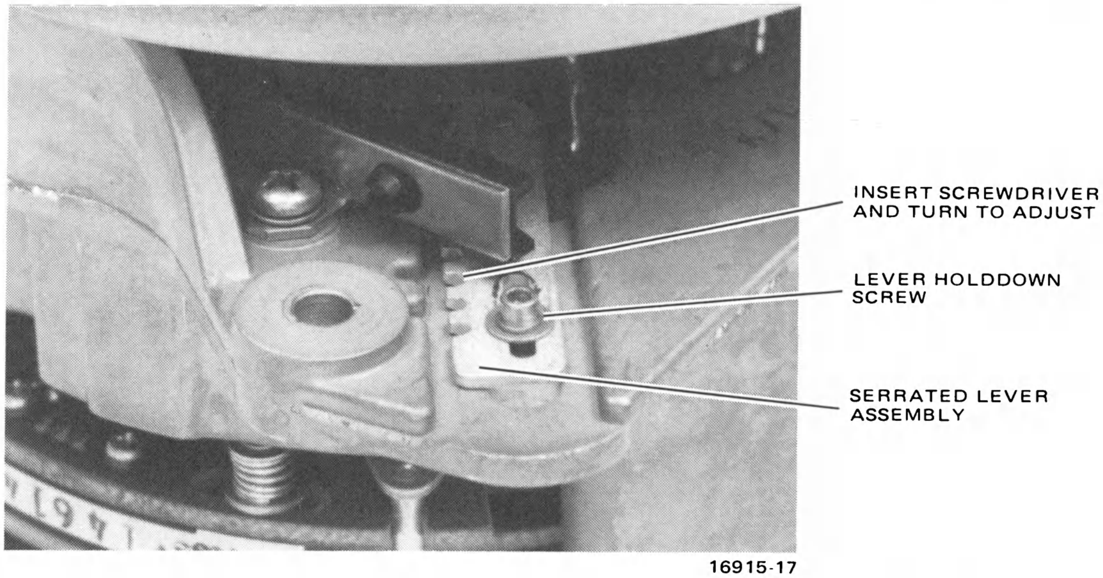


Figure 6-57. Scanner Once-Around Tach Position Adjustment

block) to be nominally ten horizontal lines wide (635 microseconds) for 525-line systems, or 12.5 horizontal lines wide (800 microseconds) for 625-line systems. Dropout duration increases with head wear, which causes shifting of dropout position with respect to vertical blanking interval. Lateral positioning of the guide block is provided to allow adjustment of the beginning of dropout relative to leading edge of the third or fourth vertical sync broad pulse. Table 6-4 shows timing relationships of dropout duration and position with respect to the third broad pulse and line 15 for 525-line systems as a function of tip projection. Table 6-5 shows corresponding data with respect to fourth broad pulse and line 15 for 625-line systems.

Table 6-4. Dropout Duration and Position Vs Head Tip Projection (525-Line Systems)

Tip Projection (Inches)	Dropout Duration (µs +/− 10 µs)	Dropout Start After Start of 3rd Broad Pulse (µs +/− 3 µs)
0.0012	670.0	−6.5
0.0013	667.0	−6.0
0.0014	664.0	−5.5
0.0015	661.0	−4.9
0.0016	658.0	−4.4
0.0017	655.0	−3.9
0.0018	652.0	−3.3
0.0019	649.0	−2.8
0.0020	646.0	−2.3
0.0021	644.0	−1.7
0.0022	641.0	−1.2
0.0023	638.0	−0.6
0.0024	635.0	−0.1
0.0025	632.0	−0.4
0.0026	629.0	−1.0
0.0027	626.0	−1.5
0.0028	623.0	−2.0
0.0029	620.0	−2.6
0.0030	617.0	−3.0
0.0031	614.0	−3.5
0.0032	612.0	−4.0
0.0033	609.0	−5.0
0.0034	606.0	−5.5
0.0035	604.0	−6.0
0.0036	601.0	−6.5

Table 6-5. Dropout Duration and Position Vs. Head Tip Projection (625-Line Systems)

Tip Projection (Inches)	Dropout Duration (µs +/− 10 µs)	Dropout Start After Start of 4th Broad Pulse (µs +/− 3 µs)
0.0012	803.0	11.8
0.0013	800.0	12.4
0.0014	796.0	13.0
0.0015	792.0	13.6
0.0016	789.0	14.2
0.0017	785.0	14.8
0.0018	782.0	15.4
0.0019	778.0	16.0
0.0020	775.0	16.6
0.0021	772.0	17.3
0.0022	768.0	17.8
0.0023	765.0	18.4
0.0024	761.0	19.0
0.0025	758.0	19.6
0.0026	754.0	20.2
0.0027	751.0	20.8
0.0028	747.0	21.4
0.0029	744.0	22.0
0.0030	740.0	22.6
0.0031	736.0	23.2
0.0032	733.0	23.8
0.0033	730.0	24.4
0.0034	726.0	25.0
0.0035	724.0	25.6
0.0036	720.0	26.2

6-55 Video/Sync Head Tip Projection Measurement

Use this procedure to measure tip projection using the VPR-3 tip projection gauge. See Figure 6-58.

STEP 1 Turn VPR-3 power off.

STEP 2 Remove cover trim from VPR transport.

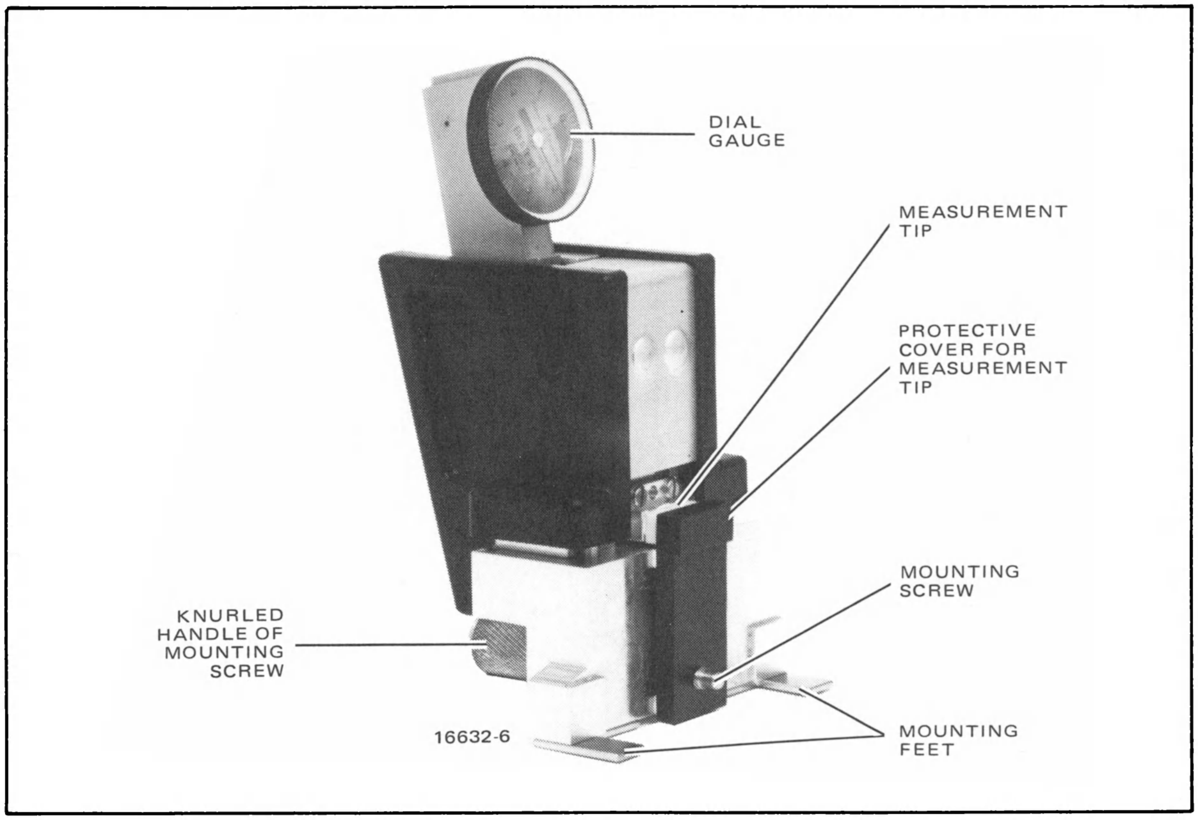

DIAL GAUGE
MEASUREMENT TIP
PROTECTIVE COVER FOR MEASUREMENT TIP
MOUNTING SCREW
KNURLED HANDLE OF MOUNTING SCREW
16632-6
MOUNTING FEET

Figure 6-58. Tip Projection Gauge

STEP 3 Clean upper and lower scanner and heads in accordance with cleaning instructions of paragraph 6-19.

STEP 4 Remove tip projection gauge from protective box.

CAUTION

TIP PROJECTION GAUGE'S MEASUREMENT TIP MUST NOT CONTACT ANY SCANNER HEAD DURING GAUGE INSTALLATION OR HEAD DAMAGE CAN OCCUR. POSITION SCANNER SO NO HEAD CONTACT RESULTS WHILE MOUNTING GAUGE ONTO SCANNER. ALSO, ALWAYS ROTATE DRUM SLOWLY WHEN GAUGE IS INSTALLED ON SCANNER.

STEP 5 Remove protective cover from gauge measurement tip by unscrewing it from the knurled mounting screw.

STEP 6 Gauge is held to the stationary drum of the scanner by means of a single screw rotated by the knurled knob on the gauge. Locate mounting hole on stationary drum (refer to Figure 6-7). With upper drum positioned so that no head will be contacted, place gauge so that gauge's two mounting feet contact bottom surface of the stationary drum, and screw engages the mounting hole; turn knob finger tight to secure gauge to scanner.

STEP 7 With gauge tip approximately 0.5 inches to the left of a head, rotate gauge outer ring to zero the gauge. See Figure 6-59.

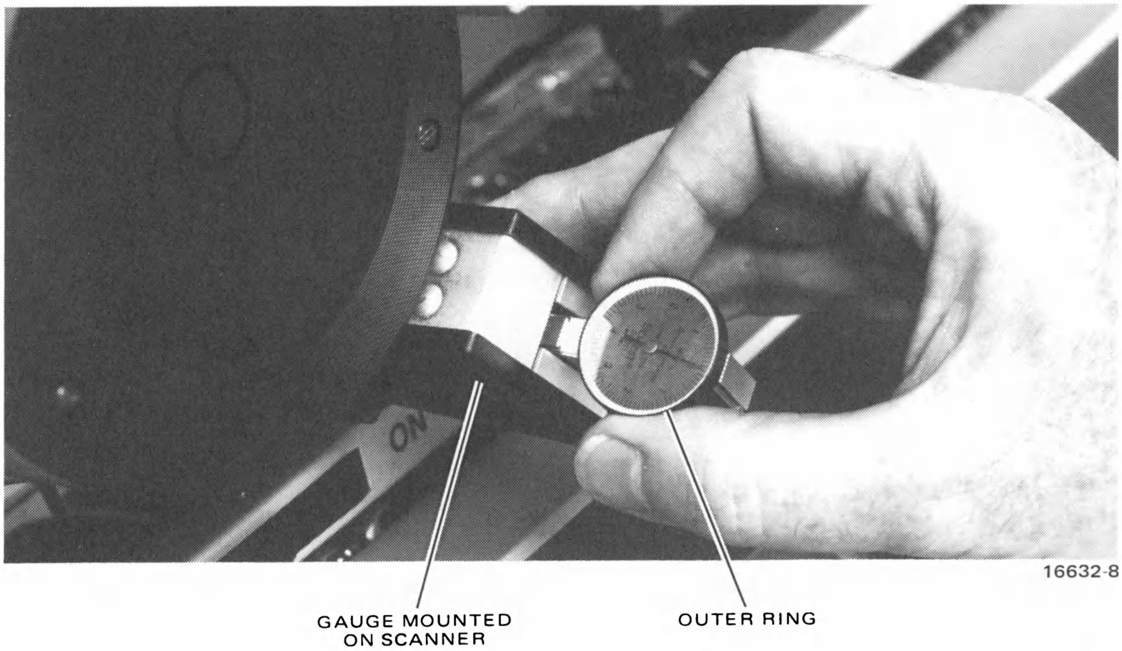


Figure 6-59. Zeroing Tip Projection Gauge

STEP 8 Rotate scanner slowly clockwise to place a head under gauge tip to measure tip projection. See Figure 6-60. Note that gauge indicates tip projection in mils, with each small increment being 0.1 mils.

STEP 9 Repeat steps 5 and 6 for all head tips.

STEP 10 When all measurements have been read, turn scanner so gauge tip is clear of a scanner head and remove gauge. Return gauge to its protective box.

STEP 11 Replace protective trim on transport.

6-56 Pin-to-Scanner Gap Measurement

The gap between scanner and pins of the entrance and exit guides is critical. This gap affects dropout duration. For this reason, pin-to-scanner gap for both guides should be measured, and adjusted, if necessary, before making dropout duration and position measurements (paragraph 6-58).

The pin-to-scanner gap procedure requires use of either precision plastic shim stock of 10-mil, 12.5-mil, and 15-mil thickness, or a precision plastic feeler gauge.

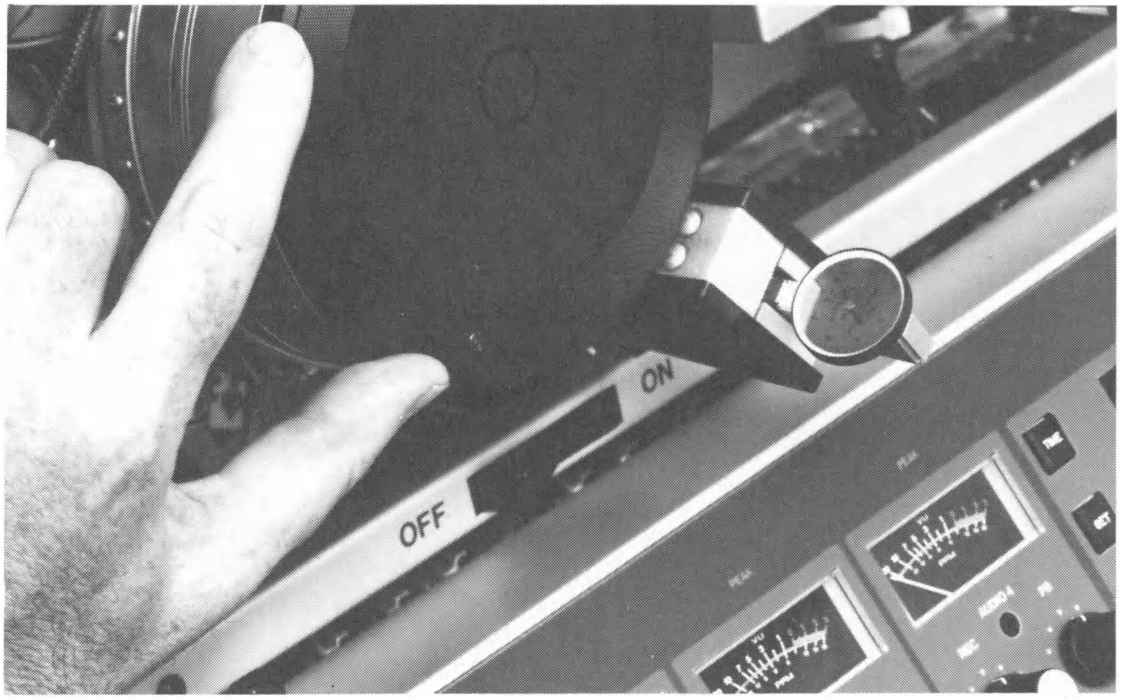


Figure 6-60. Measuring Tip Projection

No metallic feeler gauge or shim stock should be used. If precision plastic shim stock is used, it must be cut to a suitable size and shape. For handling ease, stock material should be cut into a wedge 3 inches long, the wedge being 1/2-inch at the wide end, and 1/4-inch at the narrow end, with the narrow end rounded. A precision plastic feeler gauge can be used instead if available.

The pin-to-scanner gap of the entrance guide should be 12.5 mils wide. Use 12.5-mil thick precision plastic shim stock or a precision plastic feeler gauge to measure pin-to-scanner gap of entrance guide as follows:

STEP 1 Turn off VPR power.

STEP 2 Turn scanner so PLAY head is at the 2 o'clock position. This positions AST playback head between scanner's entrance and exit guides to avoid damage during removal of protective trim.

STEP 3 Loosen and remove buttonhead hex-recessed screws securing scanner guide covers to scanner guides, and remove scanner guide covers from guides.

CAUTION

WHEN REMOVING TRANSPORT TRIM, BE CAREFUL NOT TO ALLOW TRANSPORT TRIM TO CONTACT SCANNER OR SCANNER HEADS. DAMAGE TO SCANNER OR HEADS COULD RESULT.

STEP 4 Loosen and remove screws securing transport trim to transport top plate to gain access to guide hardware. Use care not to allow trim to come into contact with scanner or scanner heads as it is removed from the VTR.

CAUTION

SCANNER HEADS MUST BE CLEAR OF ENTRANCE/EXIT GUIDES BEFORE ATTEMPTING PIN-TO-SCANNER MEASUREMENT, OR HEAD DAMAGE CAN RESULT. TURN SCANNER AS REQUIRED.

STEP 5 Turn scanner so none of the heads are near entrance or exit guides.

CAUTION

DO NOT USE A METAL FEELER GAUGE OR OTHER METAL DEVICE IN THE SCANNER OR GUIDE PIN AREA; ANODIZED SCANNER CAN BE SCRATCHED.

STEP 6 To measure pin-to-scanner gap for entrance guide, proceed as follows:

a. Insert 12.5-mil precision plastic stock (or plastic gauge) into pin-to-scanner gap of entrance guide at point along pin where head passes. See Figure 6-61.

Insert narrow end of shim stock from outside edge of guide; do not insert from inside of guides between pins. Measurement is valid only where head passes, not above or below. The 12.5-mil stock (or gauge) should penetrate the gap, but fit should be tight.

b. If the pin-to-scanner gap for the entrance guide is correct, proceed to step 7. If gap needs adjustment, proceed to pin-to-scanner gap adjustment procedure in paragraph 6-57, and adjust entrance guide before measuring pin-to-scanner gap of the exit guide.

The pin-to-scanner gap of the exit guide should be more than 10 mils but less than 12.5 mils. Gap width is determined using a go/no-go method requiring a strip of 10-mil shim stock and a strip of 12.5-mil shim stock. The pin-to-scanner gap of a properly adjusted exit guide allows the 10-mil shim to pass easily into the gap, but the 12.5-mil shim will not fit into the gap. Measure pin-to-scanner guide gap width as follows:

STEP 7 Insert 10-mil shim into pin-to-scanner gap of exit guide pin at point along pin where head passes. Measurement is valid only where head passes, not above or below. Insert narrow end of shim stock from outside edge, not from in between pins. The 10-mil shim should penetrate gap easily.

STEP 8 Use 12.5-mil stock to measure gap from outside edge. The 12.5-mil shim stock should not penetrate gap.

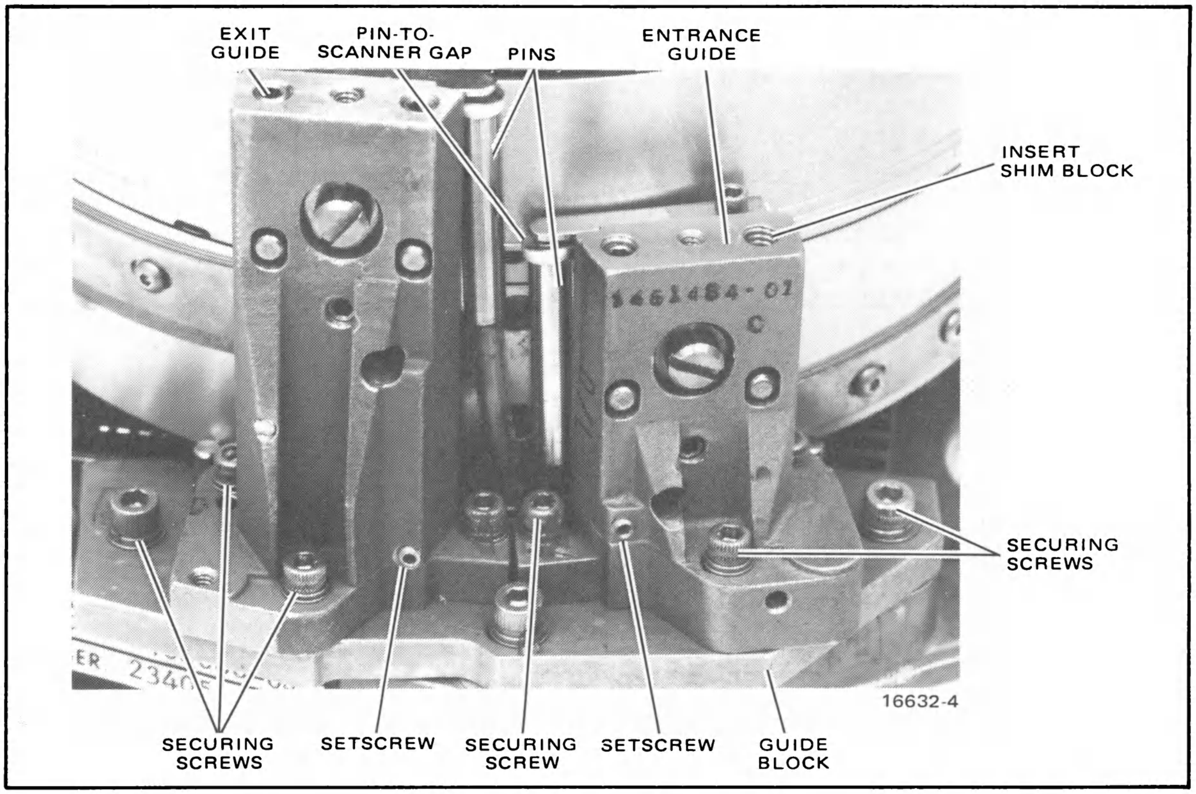


Figure 6-61. Pin-to-Scanner Gap Measurement and Adjustment

STEP 9 If pin-to-scanner gap for exit guide is correct, replace transport trim and secure it to top plate. Replace scanner guide covers. If gap needs adjustment, set pin-to-scanner gap in accordance with procedures of paragraph 6-57 before replacing transport cover and scanner guide covers.

6-57 Pin-to-Scanner Gap Adjustment

Correct pin-to-scanner gap is just under 12.5 mils for the entrance guide pin and 10 to 12.5 mils for the exit guide. If gap for either guide is too great or too small, helical scan format dropout duration will not be correct. If gap is incorrect, it must be adjusted. Adjust gap using procedure in this paragraph, then remeasure dropout duration to verify that adjusted gap is correct. This procedure applies to both entrance and exit guides.

STEP 1 Clean guide block in area around base of both guides. Use isopropyl alcohol and a cotton-tipped swab to remove dirt which can get under guide and cause misalignment.

STEP 2 Tighten setscrew until it just contacts scanner base. See Figure 6-61. Do not torque down. Setscrew can be adjusted with a special tool, or by using an off-set screwdriver. If tool is not fabricated, scanner must be removed from transport to adjust setscrew.

STEP 3 Loosen the three screws securing guide to guide block. See Figure 6-61.

STEP 4 Set gap by carefully moving guide on guide block. Turn setscrew clockwise to increase gap; turn counterclockwise to decrease gap. Press in guide gently at base so setscrew tip contacts scanner.

STEP 5 Measure gap with plastic shim stock or plastic gauge before cinching screws, to ensure that it is close to proper gap measurement (gap can change when screws are tightened). While holding guide in at base, snug the three securing screws down gently. Loosen screws and readjust as necessary. When gap is correct, tighten screws slowly, going from one to the other, until all are tight and secure.

STEP 6 Recheck gap; if incorrect, loosen securing screws and repeat step 5.

STEP 7 When adjustment is complete, loosen setscrew about two turns so that it is clear of scanner. This prevents it from digging in should guide block itself be moved or adjusted.

STEP 8 Measure helical scan dropout duration in accordance with procedures of paragraph 6-58. If dropout duration is correct, proceed with the following steps, otherwise readjust gap and remeasure dropout duration.

STEP 9 Check that spring-loaded ceramic-edge tape guide on top of exit guide pin is between 5 to 7 mils from upper drum and does not touch guide block; use a piece of plastic shim stock to make this measurement. If necessary, loosen hex-recessed cap screw that secures spring and keeper. Reposition spring and keeper and retighten screw. Verify that the ceramic extends 30 to 50 mils over front of pin; push finger forward if necessary. Make sure spring-loaded ceramic-edge guide sits squarely (parallel) on top of guide pin. Using a gram gauge, check that a 22- to 27-gram minimum force is required to lift tape guide from top of guide pin. See Figure 6-62.

STEP 10 Turn scanner play head to 12 o'clock position. Replace trim panel and guide covers, being careful not to damage a head.

6-58 Dropout Width Check and Adjustment

Measure and adjust dropout width as follows:

STEP 1 Thread a work tape on VTR, and record approximately 2 minutes of color bars on the tape.

STEP 2 After recording is complete, turn machine off and connect Channel 1 of scope to TP13 on the Mod/Demod PWA 1, and connect scope trigger to WAVEFORM MONITOR SYNC connector on rear of VPR.

STEP 3 Press RF key on control panel.

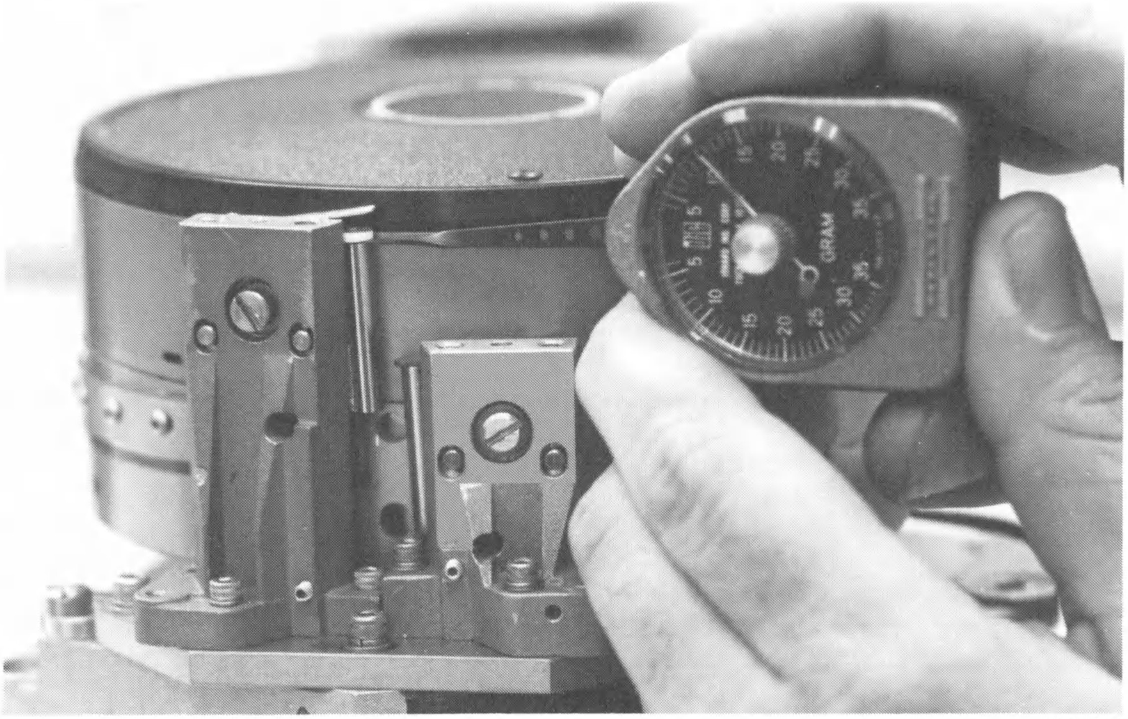


Figure 6-62. Measuring Scanner Exit Guide Spring Pressure

STEP 4 Select record head for playback and play back the 2 minutes of color bars recorded earlier; peak up rf envelope with tracking control. Editor function must be turned off.

STEP 5 Observe rf signal dropout area on Channel 1 of scope and measure dropout width; note position of dropout.

STEP 6 Refer to Table 6-4 or Table 6-5 to determine what dropout width should be based on tip projection measurement. Dropout width is affected by pin-to-scanner gap. If necessary, set correct dropout width by adjusting pin-to-scanner gap in accordance with procedure of paragraph 6-57.

6-59 Dropout Position Measurement

After verifying compliance of pin-to-scanner gap measurements to specification in paragraph 6-56, dropout duration can be assumed to be within ±10 microseconds of the duration figure in Table 6-4 or Table 6-5, which is determined by head tip projection. Measure dropout and position as follows:

STEP 1 Make a new recording, and verify dropout position and duration.

STEP 2 If necessary, perform dropout position adjustment procedures of paragraph 6-58.

STEP 3 Loosen the two screws on geared side of control track head base.

STEP 4 Connect Channel 1 of scope to input video by using a BNC T-connector in video line and connecting it to scope. Scope should be triggered from TP4 on Playback Sync PWA. Play back alignment tape. Select edit assemble mode. Select record head playback. Select unit mode.

STEP 5 Depress DEMOD VID key on control panel. This sends demod video signal to scope Channel 1.

Note

To ensure that you have not inadvertently loaded tach phase into software memory, perform a "first birthday." This will cancel previous tach phase information, and allow proper setup of record phase and dropout position.

STEP 6 Verify that reference video (Channel 2) and demod video (Channel 1) are field-locked. Expand time base to view vertical interval. Adjust control track head so that vertical sync of reference video lines up with vertical sync of demod video ±5 microseconds. See Figure 6-63.

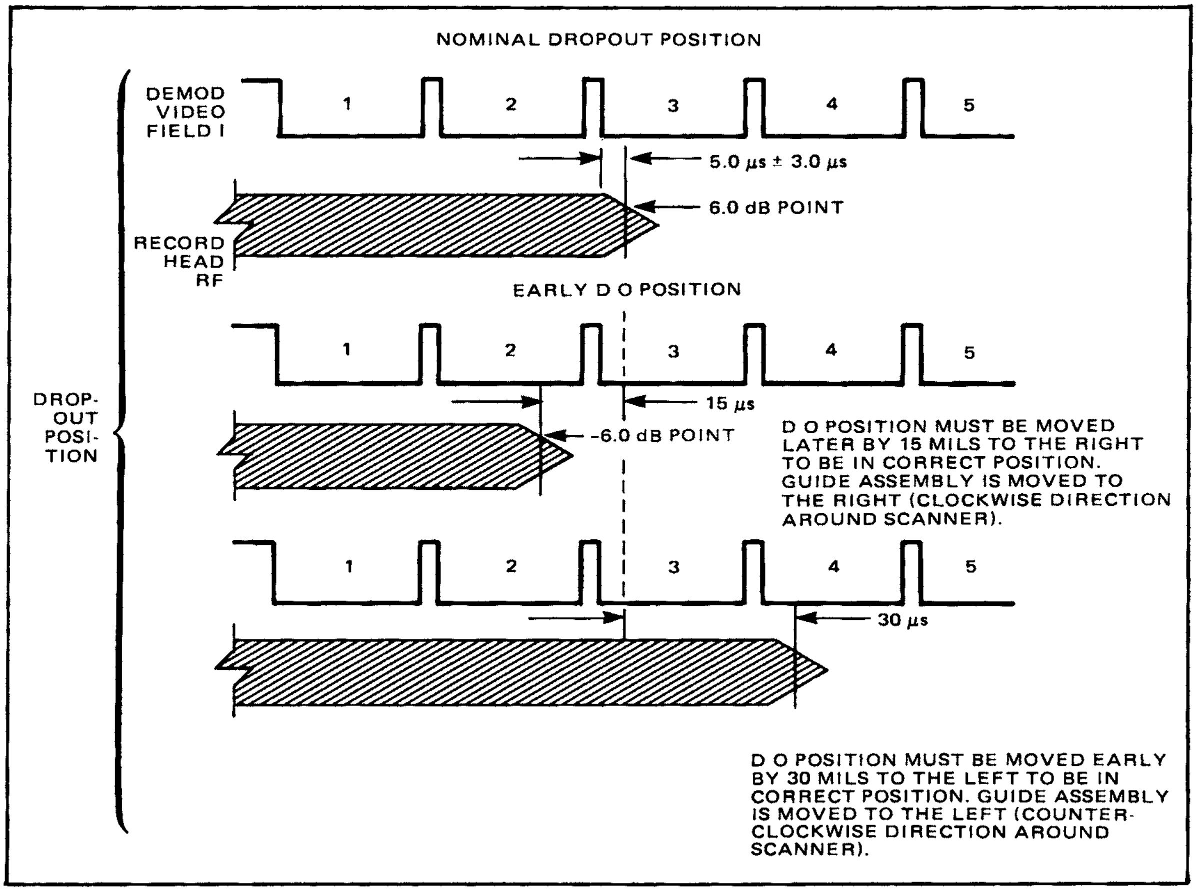

NOMINAL DROPOUT POSITION
DEMOD VIDEO FIELD I
1
2
3
4
5
5.0 µs ± 3.0 µs
6.0 dB POINT
RECORD HEAD RF
EARLY D O POSITION
15 µs
-6.0 dB POINT
D O POSITION MUST BE MOVED LATER BY 15 MILS TO THE RIGHT TO BE IN CORRECT POSITION. GUIDE ASSEMBLY IS MOVED TO THE RIGHT (CLOCKWISE DIRECTION AROUND SCANNER).
30 µs
DROP-OUT POSI-TION
D O POSITION MUST BE MOVED EARLY BY 30 MILS TO THE LEFT TO BE IN CORRECT POSITION. GUIDE ASSEMBLY IS MOVED TO THE LEFT (COUNTER-CLOCKWISE DIRECTION AROUND SCANNER).

Figure 6-63. Dropout Position

STEP 7 Adjust scope to view horizontal sync pulses after dropout area. Adjust control track head base so that horizontal sync of reference video lines up with horizontal sync of demod video ±1 microsecond.

STEP 8 Depress STOP and remove master guide alignment tape from VTR. Tighten screws down on control head base. Switch record lockout switch (S1 on Control PWA 20) to OFF position.

6-60 Dropout Position Adjustment

To adjust dropout position, proceed as follows:

CAUTION

MAKE ALL MECHANICAL ADJUSTMENTS WHEN POWER IS OFF AND SCANNER IS NOT ROTATING. OTHERWISE, DAMAGE TO HEADS CAN OCCUR.

STEP 1 Remove transport trim and scanner guide covers to gain access to the scanner guide block securing screws.

STEP 2 Determine from helical scan procedure of paragraph 6-54 the amount of dropout position error, and whether dropout appears early or late. If dropout is late (in excess of 3 microseconds), guide block must be moved to the left. If dropout is early (less than 3 microseconds), the guide block must be moved to the right. One mil of guide block movement is equal to 1 microsecond. (Note: 1 mil equals 0.0254 mm.)

Note

Note eccentric stop and lockscrew located to right of guide block plate (see Figure 6-64). Eccentric stop is used as a reference to adjust guide block position and, after adjustment, permits same guide block to be removed from scanner and reinstalled without need for dropout position readjustment.

STEP 3 If dropout is early, guide block must be moved to the right as follows:

a. Loosen screw that secures eccentric stop and use feeler gauge to set spacing in mils (1 mil equals 1 microsecond) between eccentric stop and guide block. See Figure 6-65. Tighten eccentric stop screw.

b. Loosen the three hex-recessed screws that secure guide block to scanner casting.

c. Slide guide block to the right so that guide block edge is pressed against eccentric stop, and guide block locating pins are resting against lower scanner. Then tighten the three hex-recessed screws according to tightening sequence given in Figure 6-64. Do not fully tighten any one screw on first pass. It is recommended that three tightening passes be made before full torque is applied.

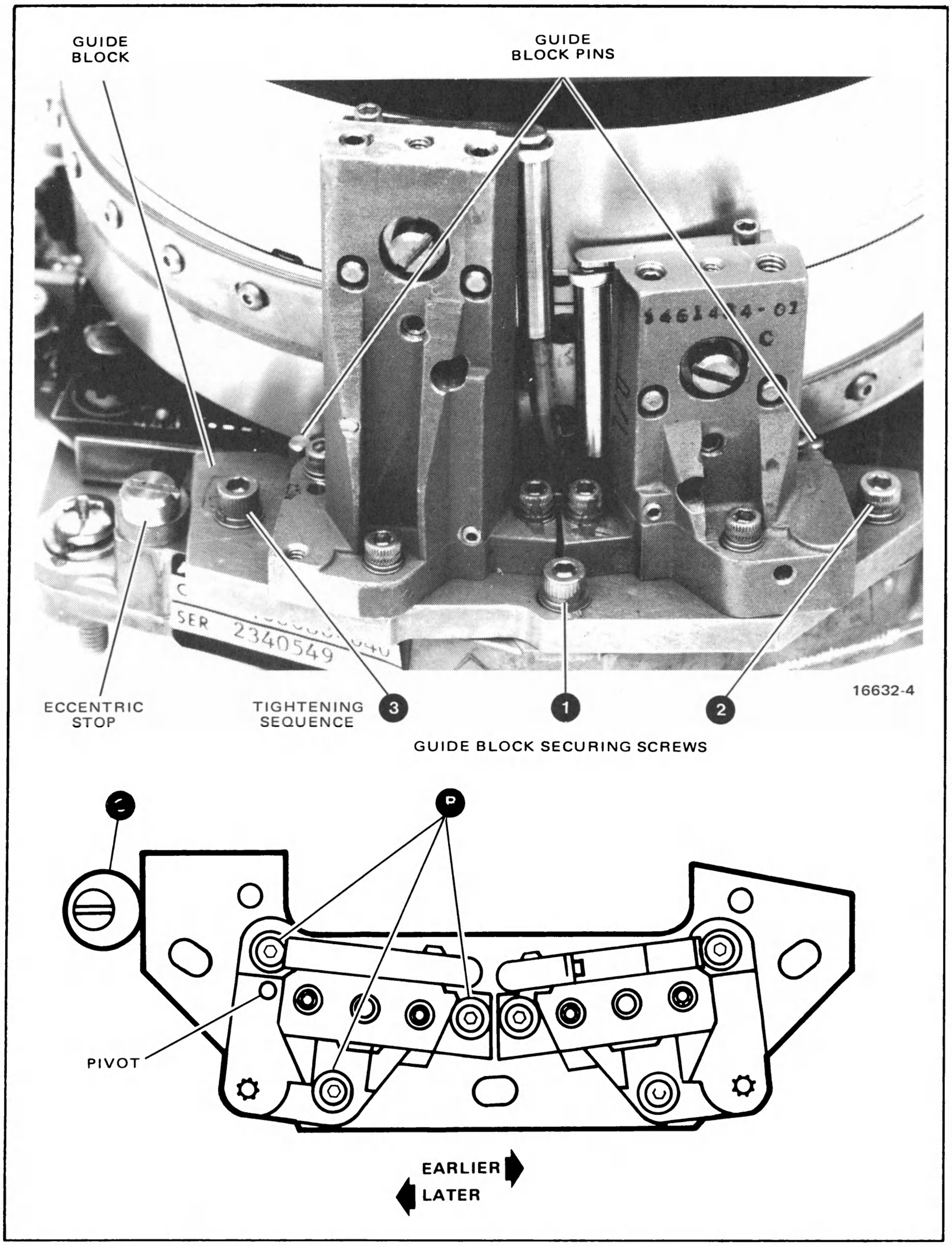


Figure 6-64. Dropout Position Adjustment

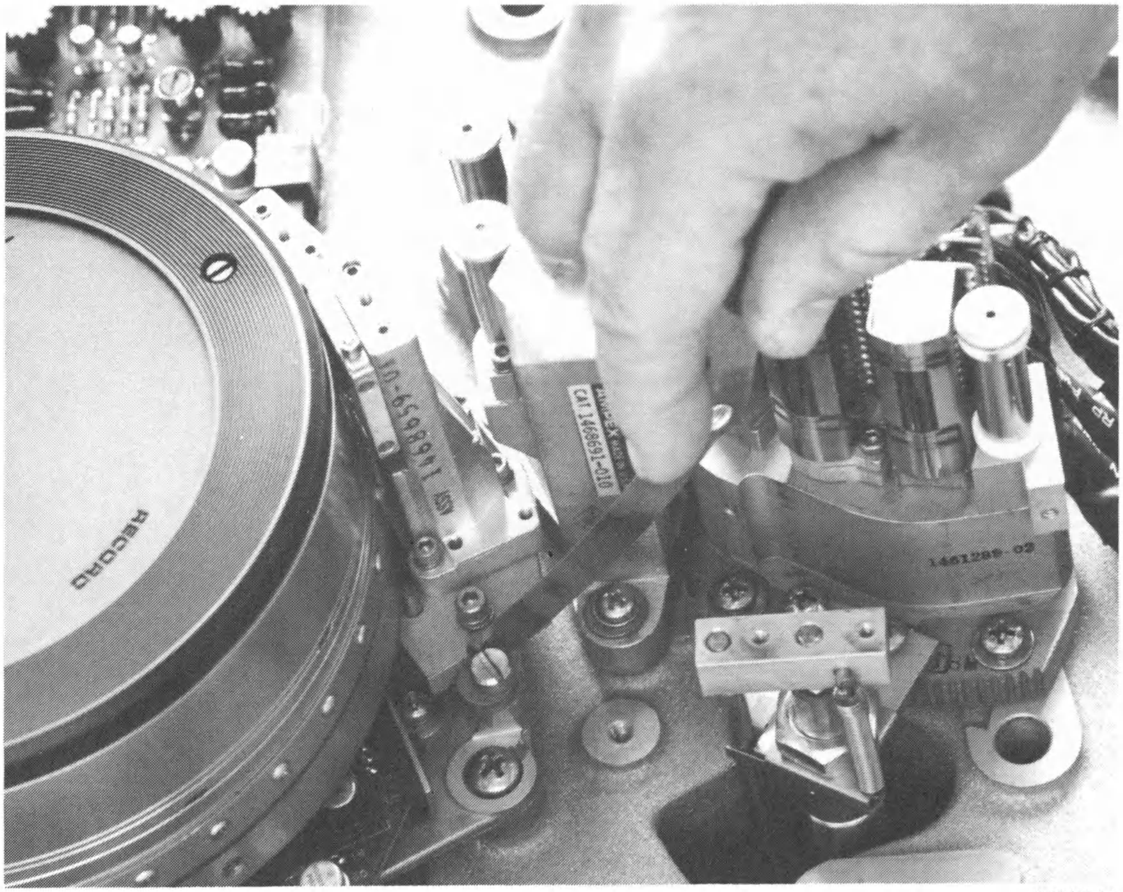


Figure 6-65. Setting Eccentric Stop Gap

STEP 4 If dropout is late, guide block must be moved to the left as follows:

a. Loosen three hex-recessed screws that secure guide block to scanner casting. Slide guide block to left and use a feeler gauge to set spacing between eccentric stop and guide block. See Figure 6-65.

b. While maintaining spacing set in step 4A, press guide block locating pins against lower scanner, and tighten the three hex-recessed screws according to tightening sequence noted in Figure 6-64. Do not fully tighten any one screw on first pass. It is recommended that three tightening passes be made before full torque is applied.

c. Loosen screw that secures eccentric stop, and rotate eccentric stop against guide block. Then tighten eccentric stop screw.

6-61 Control Track Position Measurement and Adjustment

Control track position is checked using the same procedures as for scanner tachometer position, except that tracking must be in UNITY.

Proceed as follows:

STEP 1 Set up oscilloscope:

a. Set trigger to waveform monitor sync using a BNC T-connector on back of VPR-3.

b. Connect Channel 1 probe to MODULATOR PWA TP13. Select DEMOD VIDEO on the Control Panel.

STEP 2 Set up the VPR-3:

a. Home Menu—edit assemble mode

b. Servo Set-Up Menu—tracking to unity

c. Video Set-Up Menu—record head playback

STEP 3 Playback guide alignment tape with TRACKING in UNITY position. Momentarily depress TAPE/EE switch on RF EQUALIZER PWA 3, and adjust scope to place start of vertical broad pulse on a convenient graticule marking. Observe that the two vertical sync intervals are coincident, ±5 microseconds, and on the same field. See Figure 6-66.

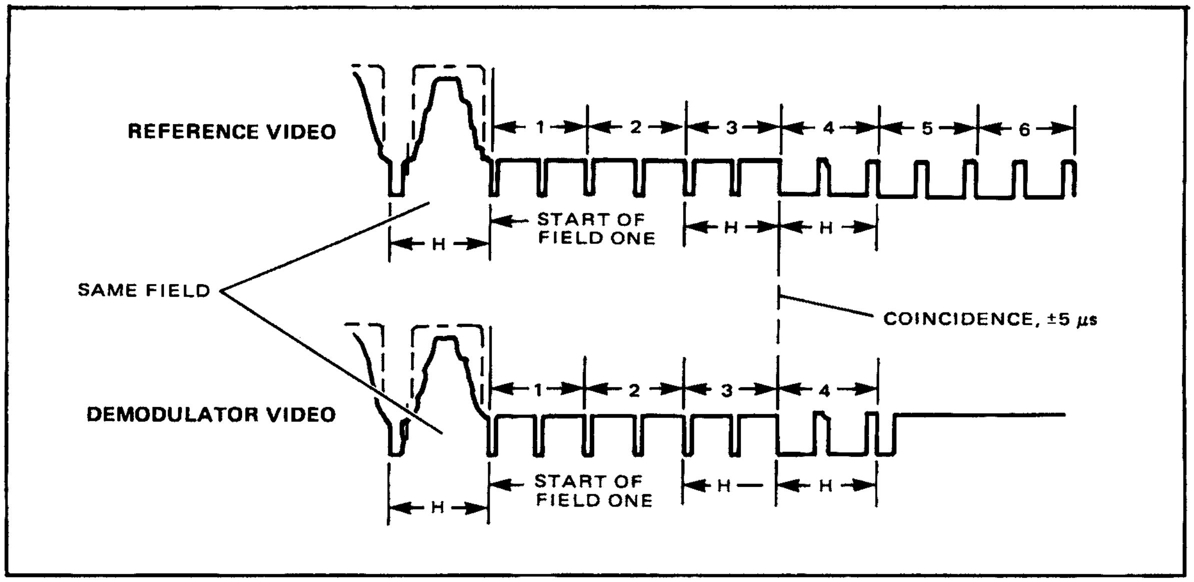


Figure 6-66. Reference Video Signal Coincidence with Demodulator Video Signal

If timing is not within ±5 microseconds, the longitudinal head assembly containing audio and control track heads must be adjusted as follows:

STEP 1 Loosen the two screws (A) in Figure 6-67 so that head assembly can pivot (B).

STEP 2 Play back guide alignment tape. Move head assembly to achieve coincidence between demod and reference vertical, ±5 microseconds. A movement of 1/6-inch represents a one-field displacement.

STEP 3 Adjust oscilloscope to observe horizontal sync after dropout. Adjust, if necessary, for coincidence within ±1 microsecond. Tighten screws on Longitudinal Head Assembly base.

STEP 4 Disconnect oscilloscope and return VPR-3 to normal settings.

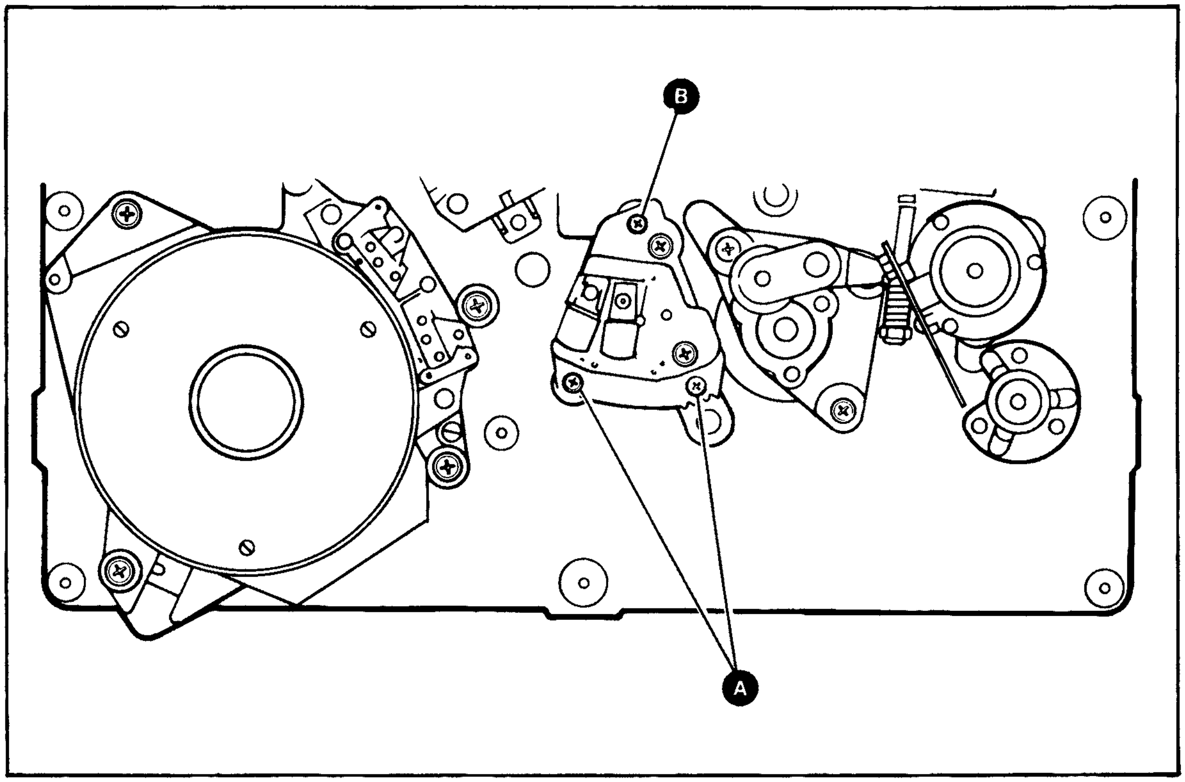


Figure 6-67. Control Track Position Adjustment

SECTION 7
AUDIO SYSTEM

7-1 GENERAL

This section provides theory of operation and maintenance information for the VPR-3 audio system. Major audio system components are shown in Figure 7-1.

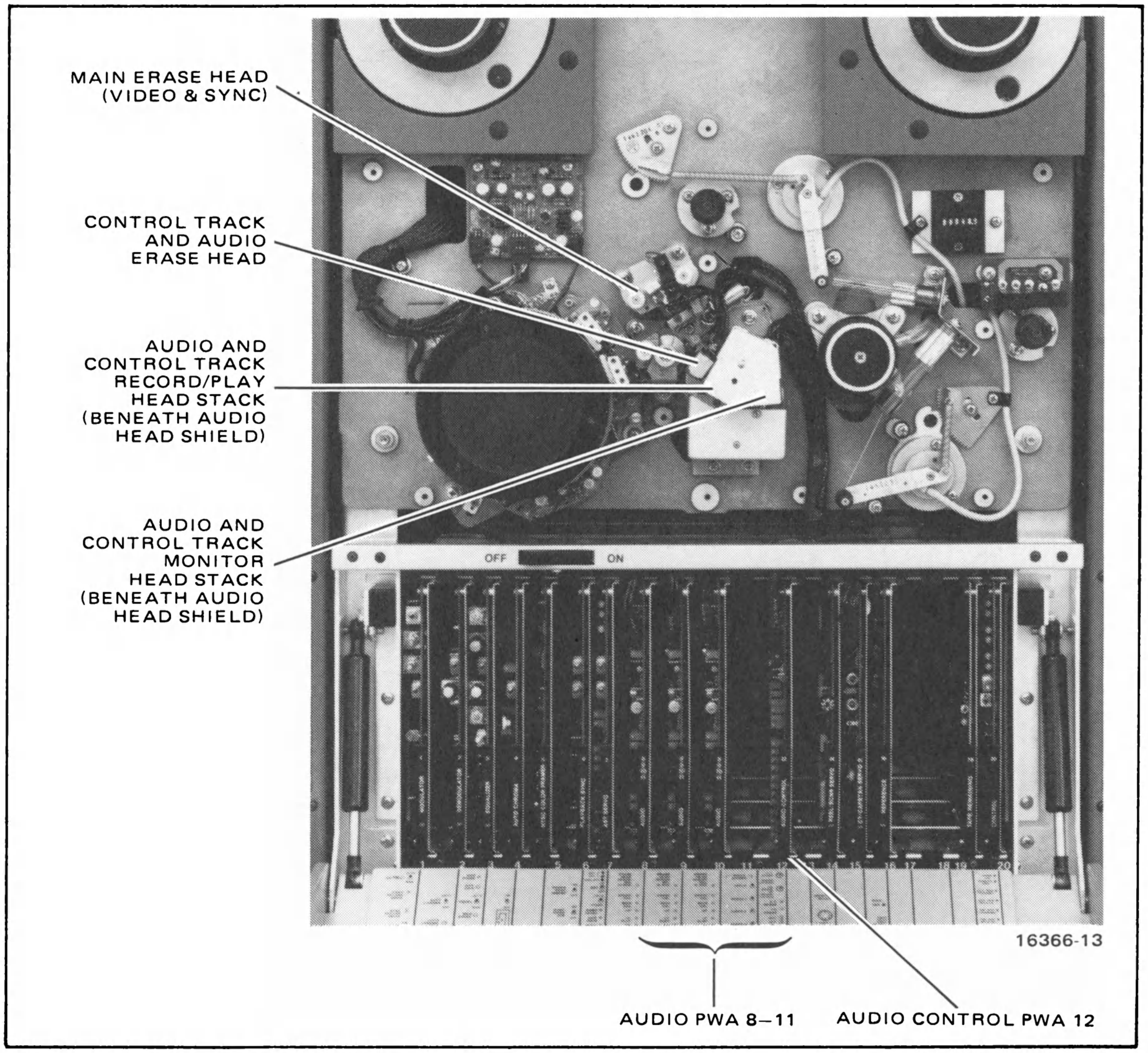

MAIN ERASE HEAD (VIDEO & SYNC)
CONTROL TRACK AND AUDIO ERASE HEAD
AUDIO AND CONTROL TRACK RECORD/PLAY HEAD STACK (BENEATH AUDIO HEAD SHIELD)
AUDIO AND CONTROL TRACK MONITOR HEAD STACK (BENEATH AUDIO HEAD SHIELD)
OFF
ON
16366-13
AUDIO PWA 8—11
AUDIO CONTROL PWA 12

Figure 7-1. VPR-3 Audio System Components

7-2 Audio System Theory of Operation

The VPR-3 audio system (see Figure 7-2) provides signal processing necessary for recording, playback, and monitoring of up to four audio channels. Record parameters (equalization, predistortion, bias, and record current level) for each channel can be set manually or automatically.

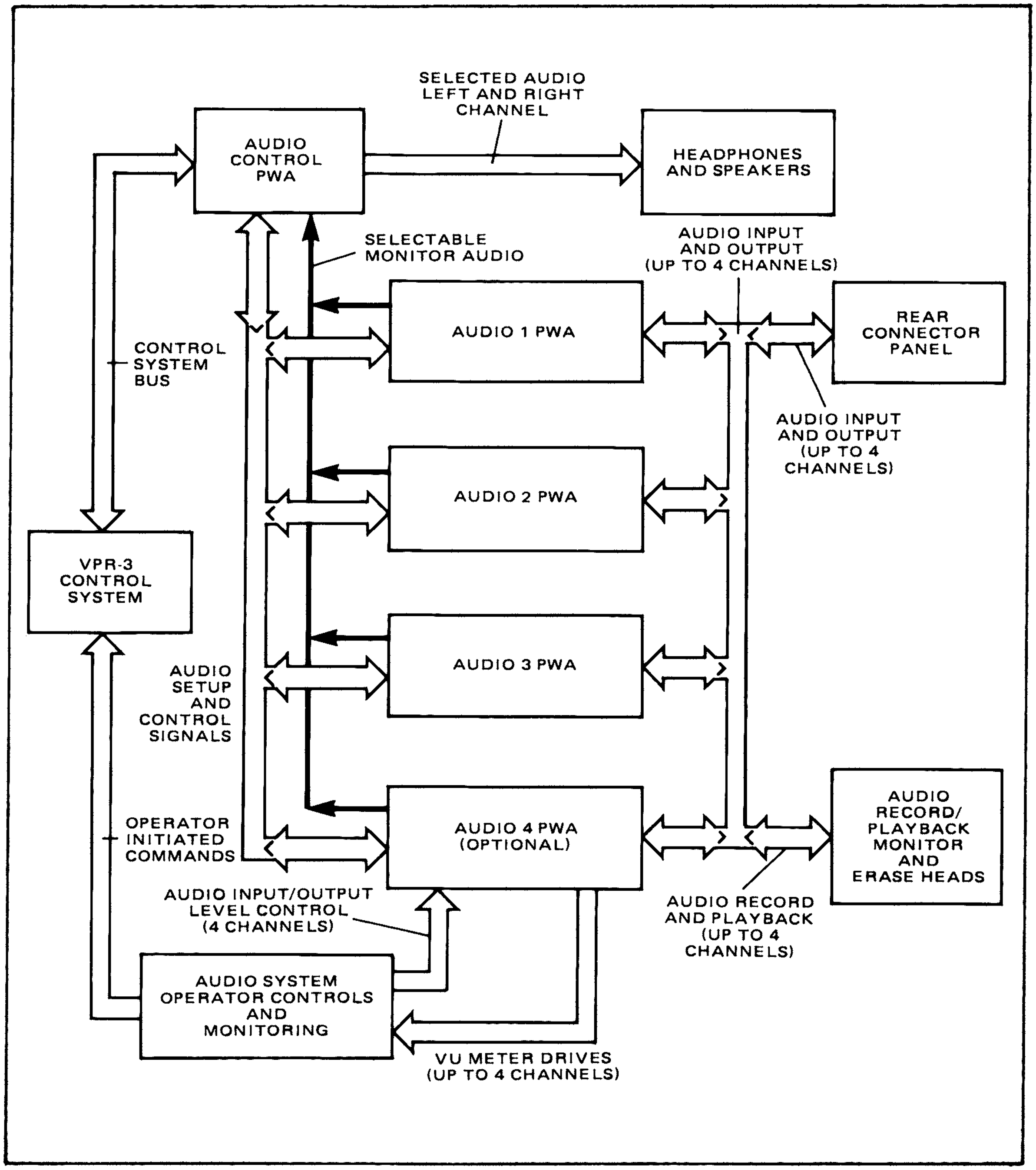

SELECTED AUDIO LEFT AND RIGHT CHANNEL
AUDIO CONTROL PWA
HEADPHONES AND SPEAKERS
SELECTABLE MONITOR AUDIO
AUDIO INPUT AND OUTPUT (UP TO 4 CHANNELS)
CONTROL SYSTEM BUS
AUDIO 1 PWA
REAR CONNECTOR PANEL
AUDIO INPUT AND OUTPUT (UP TO 4 CHANNELS)
AUDIO 2 PWA
VPR-3 CONTROL SYSTEM
AUDIO 3 PWA
AUDIO SETUP AND CONTROL SIGNALS
OPERATOR INITIATED COMMANDS
AUDIO 4 PWA (OPTIONAL)
AUDIO RECORD/ PLAYBACK MONITOR AND ERASE HEADS
AUDIO INPUT/OUTPUT LEVEL CONTROL (4 CHANNELS)
AUDIO RECORD AND PLAYBACK (UP TO 4 CHANNELS)
AUDIO SYSTEM OPERATOR CONTROLS AND MONITORING
VU METER DRIVES (UP TO 4 CHANNELS)

Figure 7-2. Audio System Block Diagram

During automatic optimization, the VPR-3 incrementally varies record parameter values while generating a test frequency. Audio PWAs respond with feedback information, allowing the system to determine optimum record values. These values are then transmitted back to the Audio Control PWA, where they are digitized and stored in memory. Optimized record parameters are read from memory and sent to individual Audio PWAs.

In record mode, the Audio PWA receives incoming audio signals, as well as control and setup information from the Audio Control PWA. Data from the Audio Control PWA is decoded to provide record parameter values and control signals necessary to optimize record circuitry characteristics.

During playback, playback signal processing circuitry on the Audio PWA receives incoming signal from the playback head. The processed signal is sent either to output circuitry for transmission to both an audio output port and the control panel, or to the audio processor port. The audio processor port allows the processed signal to be interfaced with external noise reduction or time-compression/expansion equipment. This PWA also contains monitor and erase head circuitry.

Audio PWAs occupy slots 8 through 11 in the VPR-3 electronics bay corresponding to audio channels 1 through 4, respectively. Audio channel 4, an option available for use with 625-line systems, is used in place of the sync channel. Each of these identical PWAs contains circuitry required to receive and process one channel of audio.

The Audio Control PWA interfaces the VPR-3's control system to the audio system. The Audio Control PWA receives audio system setup and control commands provided by the control system and distributes them throughout the audio system. During automatic setup of the audio system, the Audio Control PWA continually monitors off-tape audio level and distortion in the channel being set up, digitizes the measured level, and provides this data to the control system. Potentiometer controls for equalization, predistortion, bias-level, and record-level parameters in the system's audio channels (up to four) are located on the front edge of this PWA; when manual control of the audio system is selected, control settings provide reference voltages which are digitized and sent to the appropriate Audio PWA to control parameters. This PWA also generates an audio test tone used during automatic audio setup, provides erase currents to erase heads for erasure of control, video, and sync tracks, and provides the drive for headset and console speakers. Circuitry for two-channel audio mixing is provided. In addition, some video system control is exercised by this PWA.

7-3 Audio PWA, A8, A9, A10, A11, Assembly No. 1467086

Audio PWA circuitry can be separated into six major functional blocks:

- Command decoding
- Input circuitry
- Record signal processing

- Playback signal processing
- Bias and erase control
- Output line drivers

See Figure 7-3 for the Audio PWA block diagram.

Command decoding logic receives control, monitoring, and setup data from the three strings of serial data output by the Audio Control PWA (DA, DE, and DC, respectively). This serial data is then converted back into parallel form. Control information from the DA string and monitoring data from the DE string are latched and directed to their respective destinations on the Audio PWA. Tape setup values from the DC string are converted to analog levels and placed in a sample-and-hold circuit. Sample-and-hold circuitry outputs these values to the record signal processing circuitry as predistortion, HF equalization, record level, and bias level control signals.

The audio signal enters the Audio PWA through differential input amplifier U7, which provides common mode rejection. The audio signal is then applied to voltage-controlled amplifier U12, U6 where the signal is adjusted to conform to the VPR-3's -3 dBu inter-loop unity gain setting. High-frequency components are removed in low-pass filter U11. The signal is then passed to a group delay circuit, which forms a phase predistortion stage that modifies signal phase characteristics. The phase-shifted signal is placed onto the audio processing loop through the relay K3 contacts, which either routes the signal directly to the record signal processing circuitry, or passes it first through accessory audio processing equipment.

The record signal processing circuitry applies tape preset values to the incoming audio signal. Outputs of the various preset circuits are summed with the original audio input, and the corrected signal presented to record signal driver U2, U3. Driver output is filtered and routed through relay K1 contacts to a switch, which sends the signal to the record/playback head (record mode).

Serial data string DC containing setup commands for predistortion, equalization, record, and bias levels enters the PWA at pin 54 and is loaded into 8-bit shift register U47. Each 8-bit data byte is converted to a voltage level in digital-to-analog converter U56. Each of the predistortion, equalization, record, and bias voltage levels thus produced is switched through multiplexer U38 and applied to individual sample-and-hold circuits. Outputs of the sample-and-hold circuits are applied to voltage-controlled amplifiers that govern the amount of high-frequency boost, predistortion, record drive gain, and bias level used during recording.

In playback mode, audio signals from the record/playback head are received by record signal processing circuitry, and passed to a first-stage preamplifier. Preamplifier output is routed through crosstalk cancellation and low-frequency equalization circuits before being input to a summing amplifier. The other input to the summing amplifier is the audio signal from the monitor head. Either the playback or monitor head signal can be selected as the amplifier output.

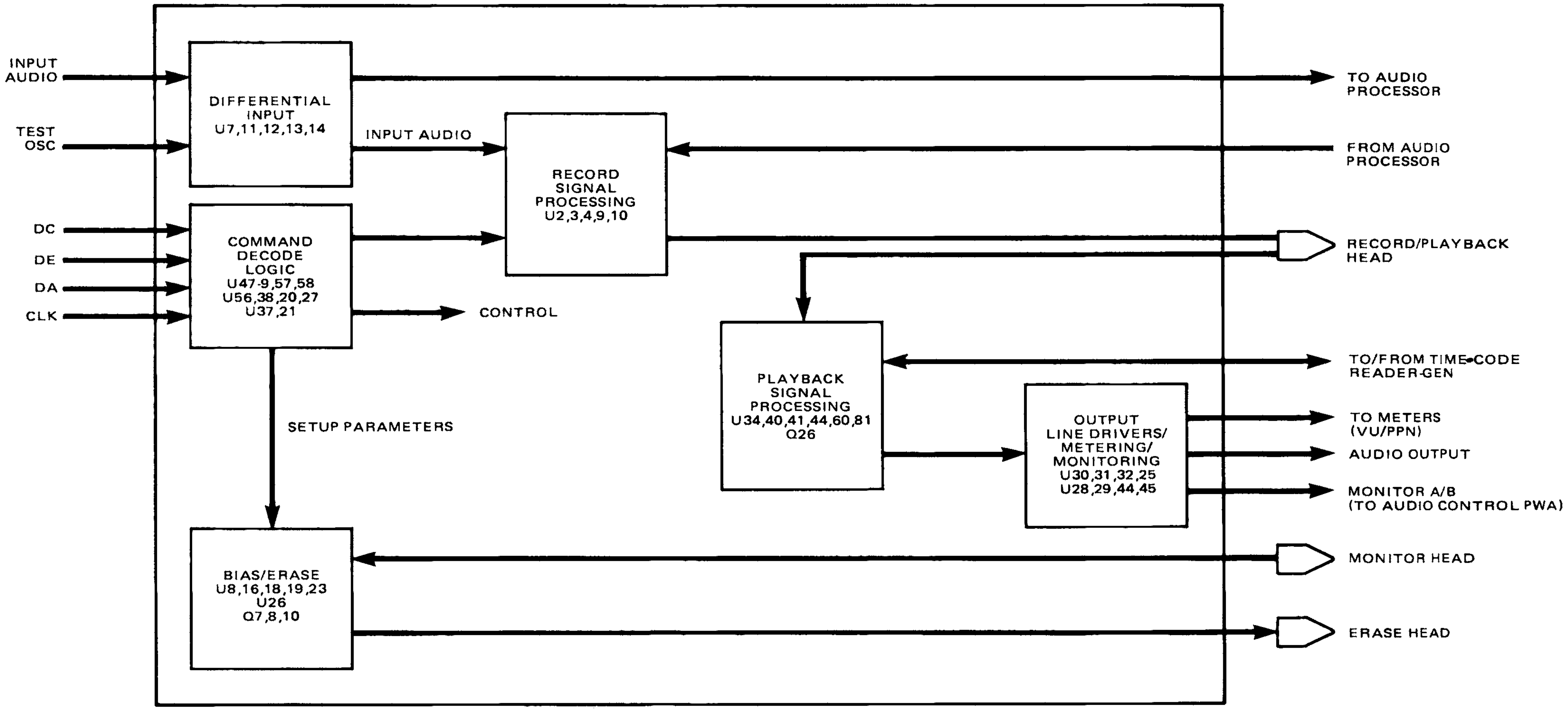

INPUT AUDIO
TEST OSC
DC
DE
DA
CLK
DIFFERENTIAL INPUT U7,11,12,13,14
INPUT AUDIO
COMMAND DECODE LOGIC U47-9,57,58 U56,38,20,27 U37,21
CONTROL
SETUP PARAMETERS
RECORD SIGNAL PROCESSING U2,3,4,9,10
PLAYBACK SIGNAL PROCESSING U34,40,41,44,60,81 Q26
OUTPUT LINE DRIVERS/ METERING/ MONITORING U30,31,32,25 U28,29,44,45
BIAS/ERASE U8,16,18,19,23 U26 Q7,8,10
TO AUDIO PROCESSOR
FROM AUDIO PROCESSOR
RECORD/PLAYBACK HEAD
TO/FROM TIME-CODE READER-GEN
TO METERS (VU/PPN)
AUDIO OUTPUT
MONITOR A/B (TO AUDIO CONTROL PWA)
MONITOR HEAD
ERASE HEAD

Figure 7-3.
Audio PWA Simplified Block Diagram

Selected amplifier output can be sent to either a low-pass/notch filter combination or to a boosting filter. The notch filter portion of the low-pass/notch filter combination is used only when the PWA is installed in card cage slots 3 or 4, and when SMPTE equalization is desired. The boosting filter is selected when the VPR-3 is in shuttle mode.

Output of the selected filter is transmitted to the I/O panel as TIME CODE OUT. In addition, the low-pass filter provides the playback signal to output line drivers regardless of whether or not it has been selected.

Bias and erase control consists of two similar circuits, which provide bias and erase signals to the record/playback and erase heads, respectively. The principal element of both bias and erase control is the voltage ramp circuitry, which produces a linear voltage ramp that controls amplitude of the bias and erase signals. Both voltage ramp outputs pass through switching circuits, and are routed to a pair of driver stages.

Bias driver output is sent to a series-resonated transformer, which generates the high-voltage/low-current drive needed by the record head. Erase driver output is passed through a resonating circuit, whose capacitance is selected by a 16-position switch on the Audio PWA card edge, and then transmitted to the erase head.

Output line drivers receive signals from either the input circuitry or the playback signal processing circuitry. The desired input is switch-selectable, with switch output routed to a differential output stage. This output stage will also accept a second audio signal from another Audio PWA, which can be mixed with the first signal. The signal produced by the differential output stage is sent to a pair of amplifiers and driven off the PWA as HI LOW V OUT. Audio PWAs also contain circuitry used to drive audio signals out to the monitors, and to select either VU or PPM metering.

7-4 Audio PWA, Record Path

A detailed block diagram of the Audio PWA is given in Figure 7-4.

U7 provides a transformerless differential input to the VPR-3. The circuit operates with either a large ac common mode signal or a differential dc signal, and still passes the differential audio signal, much like a good transformer. The input stage can handle common mode signals of up to 65V RMS from 20 Hz to 5 KHz continually with no effect on the audio system. High-frequency common-mode rejection is typically -80 db at 10 kHz. For those with power line noise problems, common-mode inputs of up to 240V RMS can safely be handled for short periods, with the machine meeting signal-to-noise specifications for inputs up to 120V RMS (at both 50 or 60 Hz).

The feedback circuit formed around U13 compensates for any dc without using an audio pass capacitor. Feedback gain increases as frequency goes lower. At dc, the very high gain of U13 causes any voltage appearing at U7 pin 6 to be cancelled to within the dc input offset of U13. The machine will handle a differential dc input of up to 15V with no effect on differential audio. The differential input circuit is balanced using R59, a factory preset.

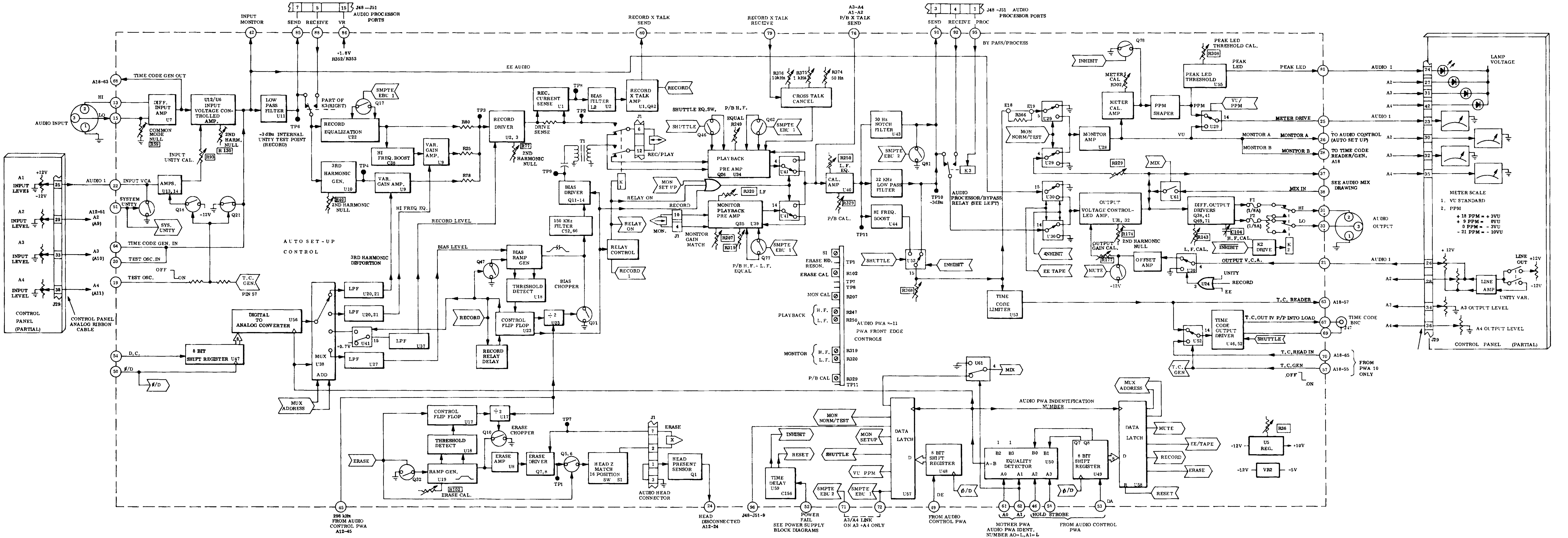


Figure 7-4.
Audio PWA Detailed Block Diagram

In the case of an Audio PWA that is plugged into the audio 3 channel slot of the electronics bay, the audio signal out of the PWA differential input circuit is sent to the time-code generator via pin 68. In all audio channels, this signal is passed to the input voltage-controlled amplifier comprising U6, R48, R51, R92, R131, and U12. U12 is a dual-operational transconductance amplifier (OTA). An OTA is a current amplifier, with output current equal to a constant times the input current multiplied by a control current.

R130 nulls second harmonic distortion that may otherwise appear at the output of the OTA stage by nulling the input offset to the devices; this is adjusted at the factory.

U13 and U14 along with R137, R93, and R94 generate the two inverse dc control currents used by the two-stage input OTA. Linear control voltage appears at pin 22, and varies from -12V for full gain to +12V for full attenuation, with ground as unity. When system unity has been selected on the control panel, pin 51 is high, causing Q22 to ground the control to the input OTAs. Q18 mutes the audio input if either the audio test oscillator is on or this PWA is being used in the Audio 3 channel slot with the internal time-code generator. Back-to-back diodes in the U13 feedback circuit limit the input OTA gain range to create a better feel in the input gain control on the control panel.

The input stage and the output line driver convert a signal of known amplitude to a signal of another known amplitude. In the case of the input circuit, the plant audio line distribution level is converted to an inter-loop level for use on the Audio PWA. No standard exists for unity in audio line level distribution systems, while the inter-loop unity level needs to be known and fixed for the audio system to operate optimally. Therefore in the VPR-3, a level of -3 dBu has been defined as being unity gain in the Audio PWA inter-loop as measured at TP6. Input and output circuits have been designed to allow the user to adjust line input and output levels to whatever plant unity is within a range of from -10 dBu to +10 dBu, while still maintaining a -3 dBu inter-loop level. Having a known inter-loop unity gain level eliminates the traditional EE calibration control.

The audio signal output of the input gain control circuit U12-9 is passed to an input low-pass filter consisting of U11A, R90, R91, C15, and C63. This is a two-pole unity gain butterworth filter, with the -3 dB point at 35 KHz. It is an ultrasonic filter that keeps the spectrum of the record signal within the audio band, thus eliminating any high frequencies which could cause signal-to-noise problems even though frequencies are not audible. Output of this low-pass filter is passed to the output line driver circuit as the EE signal, and to the Audio Control PWA for use in the input monitoring circuit.

U11B, R41, R88, R89, and C44 form a phase predistortion circuit. Inherent in all tape recording is a group delay problem, which can be most easily seen by recording and playing back a square wave. The phase predistortion circuit is designed to provide a recording with a constant group delay by phase-shifting high frequencies with respect to the low frequencies in the record signal. The resulting recording has good overall group delay characteristics (thus reasonably good square wave response) independent of the playback machine.

7-5 Audio Processor Loop

Output of the phase predistortion circuit is fed to the audio encode processor send connector (pin 85). The audio processor can be connected to the VPR-3 using connectors provided on the VTR back panel. A separate connector has been provided for each channel. The audio processing loop is normally bypassed by K3. If K3 is energized, then the encode processor is switched into the circuit. Since the signal at this point is always -3 dBu for -VU, any unity-gain type device can be connected to this port. Such devices as Dolby, DBX, or other noise reduction circuits, equalizers, and peak limiters or compressors can be inserted into the record path via the encode processor loop.

Audio from the encode processor loop is fed to record processing amplifiers, where equalization and predistortion are added to the record signal before being passed on to the record driver. U10 and U19A form the predistortion circuit. U10 consists of two OTAs wired in series, with control current fed by a full-wave rectifier circuit.

The predistortion circuit produces a signal comprised partly of the fundamental frequency and partly of the third harmonic frequency. Since distortion from off tape is mainly third harmonic, this circuit generates a signal that can be added to the record signal to cancel distortion from off tape. The cubic multiplier circuit is not perfect, however, and a residual second harmonic distortion occurs due to device offset voltages. R40 and R399 are factory presets that compensate for this distortion.

7-6 Predistortion

Variable gain amplifier U9A is the gain control for the predistortion circuit. The OTA is wired as a simple gain stage with an emitter follower current buffer output. Circuit gain, and thus the amount of predistortion added to the record signal, is controlled by the current passed through Q15 and R118. Voltage across R118 is fed from D/A converter U56.

7-7 Record Equalization

High-frequency record equalization is controlled by variable-gain amplifier U9B. C38 and R81 establish a -3 dB corner frequency of 150 KHz. The result is a boost for all frequencies below 150 kHz, with the amount of boost controlled by the gain of U9B. This gain is controlled by the voltage supplied by D/A converter U56.

7-8 Predistortion and Equalization Summation

U4B is a summation amplifier which takes the raw audio signal and adds to it the high-frequency record equalization signal and the predistortion signal, with the actual processed audio record signal appearing at TP3. U22B is an inverting amplifier that keeps the signal from the predistortion circuit in phase. Q17, C62, R127, and R124 form the low-frequency record equalization circuit around U22B. In EBU operation, Q17 is turned on, shorting C62 and making this a flat gain amplifier. In SMPTE, Q17 is turned off, allowing this stage to give a +3 dB boost at 50 Hz, as required by format specs.

7-9 Record Driver

The record driver consists of U3, U2, and associated parts. U3 is the gain adjustment, and U2 is a voltage-to-current converter. The gain of the record driver, and thus the record level, is controlled by the current in U3-16 or U3-1 which is the same value, and is adjusted via a D/A converter U56. U2B is a voltage-to-current converter having the advantage of very high output impedance (due to positive feedback in the circuit) using reasonably small component values. Current actually being used by the record head passes through R66, and is monitored by U1B, a differential amplifier, and can be seen at TP8 (which is on the end of the PWA). R77 is a factory preset that compensates for the offsets in the U3 circuit.

7-10 Record Path Troubleshooting

The input section through the low-pass filter can be tested by observing the signal at TP6. The signal here should be a band-pass-filtered signal with -3 db points of 5 Hz and 32 kHz. Barring any chip failures, there is only one fault that could cause the signal not to appear at TP6. If R130, which is factory preset, has been readjusted to one of its end stops, then U12 will saturate with no output signal. U6, however, will at least partially compensate for this, so there should be little or no apparent dc offset at TP6 with it in the circuit. If shorting U6-1 to ground causes voltage at TP6 to go to the +,-12 volt supply rail, then R130 has been misadjusted and should be reset for minimum second harmonic distortion.

If R130 has not been touched since the PWA left the factory, and still no signal occurs at TP6, observe signal at TP12 to make sure the differential input circuit is passing a signal. Next, with machine in unity, verify that voltage at U14-6 is ground, and that U13-1 is approx +2.8V; voltage at U12-1 and U12-16 is -11.4V. If all the above is correct, then a signal should appear at U12-9, U11-1, and TP6, respectively.

TP3 is used to verify that the record processing circuitry is working correctly. The signal here should be a summation of input, equalization, and predistortion signals. If any one of these is missing in the composite, the trouble can be traced. TP4 is the intermediate predistortion point, and should be biased to +6 Vdc with a very distorted signal (in effect, the predistortion signal) riding on the bias.

TP2 is used to verify that the record driver is functioning. The signal appearing here will have some bias added to it, and will not appear to have a flat frequency response because of the location of the test point in the current driver circuit. With the PWA placed into the recorder, the head connected, and the machine placed in record, current being passed through the head will appear at TP8, and this point is used to reverify that all record and bias circuitry is functioning correctly.

7-11 Erase Head Driver Circuit

Erase ramp generating circuit U19 produces a linear voltage ramp, going from ground to an amplitude that can be set by R102. Ramp time is constant. Transistor Q10 is turned on and off by a 198 kHz signal. This signal is produced by divide-by-two circuit U17, which is clocked by the 298 kHz signal generated on the Audio

Control PWA. The result at the input to erase amplifier U8 is a square wave modulated by the ramp. This is filtered, amplified, and used to drive the erase head.

Assume that voltage at U19-1 starts at ground (erase off), and call voltage appearing at the junction of R166, R170, R102, R164, C78, and U15 by the name V_{ref}. Since R167 and R74 are simply a voltage divider, V_{ref} x 1/2 appears at U19-3. U19A is an error amplifier which drives U19-2 via feedback to keep voltage at U19-1 stable at ground potential. To turn on the erase, the signal at 0 (erase) goes high. This turns Q32 off, causing voltage at U19-6 to go to V_{ref}. At this time an error occurs at the input to U19A, causing U19-7 to go to -12V. CR6 and CR5 clamp R113 to ground. This applies a current to C54 through R113, charging it at a controlled rate. Once voltage at U19-1 reaches V_{ref}, U19B feeds this back to stabilize the point at that level. If the erase signal at 0 goes low, Q32 is turned on causing U19-7 to go to +12V. This reverse-biases CR5, and C54 is charged to ramp down by current through R113 and R166.

Ramp time is independent of V_{ref}, and it takes slightly longer to ramp down than to ramp up, due to the addition of R166 to the circuit while ramping down. V_{ref} is then chopped by R62 and Q10 to form the square wave as mentioned above. This square wave is filtered by L1 and C4, and applied to erase driver U8. When erase is off, Q4 is turned on to short out the U8 feedback path and thus turn it off, and Q5 and Q6 are turned off.

When erase goes high to start the ramp, U17 is set and Q5, Q6 are turned on. This connects the head to the driver and Q4 turns off, turning on the gain of U8. When erase goes low, the ramp starts down, but U17 stays enabled, keeping Q4 off and Q5, Q6 on until the ramp reaches ground. At this point, threshold detector U18 clocks U17 to the normal off state. U17 is also set to the off state during power on reset to keep possible pops from being recorded during power cycling.

U8, Q7, and Q8 form a class B driver stage for the erase head. C24, C25, C26, C27, C28, and S1 are the resonating circuit for the head. The erase head, which is ferrite and a very high Q inductor, is driven using series resonance to improve efficiency. By rotating S1, which is a card edge 16-position switch, the resonating series capacitor is found for the particular head on the VPR. The feedback point for the erase driver is taken from the current sensing resistor connected from the opposite side of the erase head to ground. In this way, the driver compensates for slight differences in head inductance, and keeps a constant current through the head.

Full erase current is determined by the dc-voltage which the ramp circuit reaches in the ON state. This voltage is set by a variable regulator circuit, with voltage adjusted using R102.

7-12 Bias Circuit

Erase and bias circuits are similar but differ in a number of ways. The relay connected to the record head must be switched from play to record. U36 forms a 3.4 msec delay from the time the record command goes high until the bias ramp is started. This allows the relay to settle into the record position. U26 is a ramp circuit identical to the ramp used for the erase, except that the times are shorter—taking 4.2 ms to ramp on and 4.3 ms to ramp off. Bias driver U16, Q11, and Q12 forms a class B stage that drives the head. Since the record/play head is a very high-inductance metal head, it must be driven by a bias signal on the order of 200 V p-p. Transformer T1 is a series-resonated transformer which generates the high-voltage/low-current drive needed for the record head. Since it is impractical to use the record current as feedback to the bias driver to keep this stage constant, voltage on T1 is used and fed back by R154. The remainder of the bias driver circuitry is the same as for the erase driver.

7-13 Bias and Record Current Summation

The bias driver is on one side of the head, while the record driver is on the other side of the head. At the output of the record driver is a series bias filter L3, C35 which is an open circuit to the record signal, but shorts the bias signal (applied to the other side of the head) to ground. The result is that both signals are fed into the head on opposite sides, and are summed in the head. Current going through the head (both bias and record signal) is monitored by U1B, and can be observed at TP8.

7-14 Bias and Erase Circuit Testing

The bias circuit cannot be tested with the Audio PWA on an extender because the extender cable required for the head adds capacitance and cuts bias current in half, making testing of the bias circuit useless with the cable. Because of circuit parameters, the erase head still works with the extender cable, but because the record/play head does not function, the bias and erase driver should not be tested with the extender cable. This should pose no problem in the circuit testing, however, since circuit functioning can and should be tested on the extender board with no heads connected.

If there is no bias or erase current being passed through the head with the PWA installed in the machine, the first thing to check is the ramp circuitry. U19-1 and U27-1 should each ramp from ground to some positive voltage level when record is turned on. If not, then either the logic signal is not getting to the ICs or the IC is dead. Next, check that the chopper is functioning correctly. A 150-Hz sine wave should appear at both U8-3 and U17-3.

Next, check driver output (TP1 and TP9) to ensure that drivers are functioning correctly. With no head attached, the signal at TP1 should be a 150-KHz square wave saturating into the +,- 12V supplies. Do not worry if waveforms appear distorted or slew rate limited, because in this mode the amplifier is operating open-loop. The signal at TP9 should be a cleaner 150-KHz sine wave than at TP1, but it will have noticeable crossover distortion which is normal, since the driver is purely class B. Both of these signals should ramp on (to some positive voltage) and off (to ground) when record is turned on or off. If there is no signal, or if the signal is very small at the test points, check 2N5555 FET switches.

In the erase circuit, the saturated square wave should also appear at the junction of Q6, R6, and the capacitors of Q5,Q6 are dead. In the bias circuit, the signal at the junction of T1 and R105 should be a sine wave at about 100 to 200 Vp-p, which indicates that transformer T1 is functioning correctly.

With all the preceding tests met, circuits should be functioning. Relay K1 may be faulty, and should be checked to verify that it is not dead. Other than that, check for open traces to the head or a bad connector.

It should be noted that it is relatively easy to bend pins 1 and 6 up in the connector. The result is that the connector still can be plugged in, but pins 1 and 6 bend around on the top of the connector, not making connection with the circuit. This fault only affects the erase head, so if all else fails to show a fault, check the connector.

7-15 Playback Circuitry

The VPR-3 has full quality-confidence playback from a monitor head; the two preamp circuits, one for the record/play head and one for the monitor head, are nearly identical.

K1 switches the record/play head between playback circuitry and record circuitry. This relay is in the playback position until switched to the record position when record mode is entered. Points y and x connect the relay to Q26, which is the input to the preamplifier. The first stage of the preamp consists of Q26, Q34A, and associated parts. It is a differential amplifier with a flat gain of about 20 dB across the audio band. Circuit input impedance as determined by R104, R151, and R153 is about 35K ohms, and variable capacitor C69 in series with a 10 mH inductor are series resonant at bias rate to nullify adjacent channel bias ramping.

7-16 Equalization

The amplified signal from U34A is passed to the integrating stage of U34B, where playback time constants are also added to the signal. R258, R259, C112, and L7 in the input path form a sinx/x filter which compensates for the high-frequency head gap loss inherent in the playback signal. Since this circuit tends to overshoot and ring when fed with a square wave, Q46 turns the booster off during tape shuttle to allow a clean time-code signal to be passed in audio channel three. C88 is the integrating capacitor, with high-frequency equalization adjusted using R249 for a 3 dB boost at 15 microseconds (10,610 Hz). Low-frequency equalization is set by the combination of R255, R256, and C88 as determined by Q62. When Q62 is off, the low-frequency -3 dB corner is set to a time constant of 0.082 seconds (12 Hz) for EBU specified equalization. When Q62 is on, low-frequency -3 dB corner is set to a time constant of about 3160 microseconds (50.4 Hz), which is within 1% of the specified SMPTE equalization of 3180 microseconds (50.0 Hz).

7-17 Cross-Talk Cancellation

The integrating stage is where the record-to-playback crosstalk cancellation circuit is located. This circuit, which consists of U62 and associated parts, allows use of channels one and two (or three and four), with one channel in record and the other in playback. Since a large amount of transformer coupling occurs in the head, the playback channel typically picks up the record signal at a level of -6 dB (from the playback signal) with cross-talk cancellation. This circuit takes a signal from the record circuit of the adjacent channel and adds it to the playback signal out of phase with the transformer-coupled record signal to cancel the pickup.

Switching between the monitor head and the record/play head is done by U41-3, 4, 5. When the record/play head is selected, U41, 5 are connected, allowing the signal from the integrating stage to pass on to the next amplifier. When the monitor head is selected, U41-3, 4 are connected, which not only removes the amplifier from the input to the next stage, but also shorts the integrator stage. This arrangement greatly reduces inherent pops produced by the preamp when it is switched from no input load (in record) to being connected to the head, and also decreases cross talk between the monitor head preamp and the record/play preamp.

U40A is the low-frequency equalization stage. It is intended to be a simple bass control to allow the inherent low-frequency irregularities of the head to be compensated. Since the head has a typical low-frequency boost, as well as some head bumps, this control is usually set to give a slight low-frequency roll off, thus centering head bumps in the frequency response range. R250 is the low-frequency equalization adjustment and the adjustment is made to center the head bump characteristic in the off-tape playback signal. Low-frequency equalizer output is passed to U60A, which sums output of the two preamplifiers. Since only one of the preamps is turned on at one time, however, the output of U60A (and thus the signal at TP11) is either the playback signal or the monitor head signal. TP11 is located on the Audio PWA edge, and is thus useful for monitoring the phase difference between audio one and audio two while adjusting the record/play head azimuth.

7-18 Monitor Head Preamp

The monitor head preamp circuit is nearly the same as the record/play head circuit. Q25 and U39 form the flat gain first stage, with R207 used as the adjustment to match gains between the record/play circuit and the monitor circuit. R319 is the monitor high-frequency equalization control, while R320 is the low-frequency equalization, and the adjustment is made the same way as for the record/playback head. High-frequency capacitors C107 and C126, used to keep this stage from becoming an oscillator, are set to a lower frequency than those in the record/play circuit (C108 and C109) to help eliminate bias crosstalk into the monitoring circuitry. The sin x/x circuit (L8, C128, R323, R328) need not be turned off in shuttle as required for the record/play head, and so the switching circuitry is not in the monitor section. Otherwise, the rest of the circuit is identical to the record/play preamplifer

When coming out of record, the monitor head is turned off. R261 and C114 cause a delay of about 300 ms, which allows the record/play preamp to settle before being selected, and further reduces the pop which is inherent in this operation.

Playback gain is adjusted using R329 in the feedback path of U60A, and using playback from the record/play head. Monitor head preamp is adjusted to match this level using R207. U60A output is then passed to two filters consisting of U44B and U51A. U51A is a three-pole low-pass filter set at about 30 KHz, with a bias trap (150 Khz) consisting of L9 and C133 on the input. U43B is a 30-Hz notch filter which is turned on only if SMPTE equalization is selected and the PWA is installed into audio three or audio four card slots in the electronics bay, allowing cross-talk rejection from the SMPTE control track.

7-19 Boost Playback Signal in Shuttle

U44B is used to boost the playback signal in shuttle to partially compensate for the two-pole roll-off in the first stage of the head preamp. U52-1, 2, 15 then switches between the output of the low-pass filter and U44B, and passes the signal to a slicer (U53) for use by a time-code reader. The sliced signal is a 0V to 5V logic level wave which is passed to either the internal time-code reader, or the U46B output wave shaping circuit. Output of U46B is a 1.1 Vp-p square wave which is passed differentially to the time-code output BNC connector on the machine back panel. Because of circuit parameter differences, R368 is used to adjust the average level of a playback square wave signal while in shuttle with a 50% duty cycle; this adjustment is done at the factory. U52-3, 4, 5 switches U46B from a limited rise-time mode in play, to a fast rise-time mode in shuttle.

7-20 Playback Circuit Troubleshooting

Playback circuitry operates correctly only when the PWA is installed in the machine. When put on an extender PWA with a head extender cable attached, the increase in cable capacitance causes a high-frequency roll-off that affects equalization and can affect playback gain. Therefore, when checking playback circuitry with the extender cable, do not look for absolute values, look rather for the presence of signals.

The first three stages of amplification (through TP11) typically either work or don't work, and there is very little that can go wrong. If no signal is present at TP11 for either the monitor head playback or for the record/play head, then check back to make sure that the output of each op amp is near ground. The only exception to this is for op amp U39-1 and U34-1, which should be biased slightly away from ground by a couple of volts (either positive or negative is possible). Next, check that a signal is being passed through the various stages.

7-21 Line Driver, Meter, and Monitor

The differential line driver is basically two discrete high-power op amps. The circuit is fully complementary, with a class AB output stage. It is designed with output current limiting at 120 milliamps, and fused and clamped by Q66, Q67, CR14, CR15, CR20, and CR21 to prevent the output from being pulled above the +,-24V supplies. This design makes the output stage very safe; outputs can be shorted to each other, ground, and/or +,- 24V with no damage done. If line output is inadvertently connected to a power outlet of 120V, output is clamped and the protection fuse is blown. Fuses are 0.125-amp mini-fuses located on the PWA between the power transistors and the edge connector, and they should not fail unless output is abused.

The output stage requires no adjustment except if one of the feedback elements has been replaced (these are R143, R144, R194, R233, R235, R240, R241, R246, R247, C104 or C105), in which case output gains must be re-balanced. To do this, look at each of the differential outputs with a voltmeter (or two inputs of a dual trace scope) and with a 1-Khz signal, adjust R143 for exactly the same output level. With a 10-KHz signal, adjust C104 for the same output from each of the differential outputs.

If a scope is used, first make sure that the two input stages of the dual trace scope have the same gain, connect each input to a different differential output and invert one of the scope inputs, and add the two. With this display, R142 and C104 can be adjusted to null the resulting trace on the scope.

It should be noted that the feedback circuitry of the output stage causes it to act like a transformer. Thus, when a single-ended load is driven, one side of the differential output is shorted to ground, and the effective signal level at the other output will be the same as if the output were taken differentially. The only limitation to the differential output is that it is ground-referenced, while a true transformer would float.

The differential output stage is driven by an OTA stage consisting of U31, U32, and associated parts. There are two adjustments in this stage, one that is a typical user adjustment and one that requires adjustment only when a failed part is replaced. R177 is the output calibration adjustment, and is used to match the internal unity gain level of -3 dBu to the output line distribution level. This then makes the VTR system unity gain, since the input calibration level causes a level of -3 dBu on the audio PWA. If U31 is replaced, then R174 must be adjusted to balance the U31 gain stages. This is done by either toggling the mute signal while adjusting for no dc-level shift when toggled (measured at pins 31/32 or 33/34), or by adjusting for minimum second harmonic distortion in a 1-kHz signal at +10 vu at the PWA output.

R365 and U61 perform the A1 and A2 mix function. When the PWA is installed into slots 8 or 9 and the mix signal is brought high, U61-2, 15,14,12 are connected together, causing the signal from U32-7 from of the adjacent PWA to be added to the signal on U32-5. Actual gain of the output gain stage is controlled in part by U25, U30-3, 4, 5 and Q34. The U25-6 output voltage is used to create control current for U31 via R177 and R178. If Q34 is turned on by Q65, control current is in effect turned off, thus muting the output signal. Voltage at U25-6 is normally controlled by the control panel playback gain pot when U30-4, 5 are connected. If the VTR is in EE, Record, or Unity, U30-3, 4 are connected causing U25-6 to go to ground (the unity state), and inhibiting the function of the playback pot.

Gain stage input is switch-selectable by U30. This allows either the off-tape or EE signal to be passed to the output. This switch is controlled by the INPUT/TAPE switch on the control panel, with the signal from tape being from either the playback head or the monitor head. The off tape signal is also passed through the audio processing port relay K3 to allow the off-tape signal to be altered by a processor before reaching the output gain stage.

The monitor circuit and the meter circuit are much the same, since what is actually metered is the monitor output signal. The monitor amplifier is U28 and the input is switch-selected between either the output signal or the pre-mute signal by

U29. The pre-mute signal is taken from the playback circuitry at the same point as that used for time-code slicing, and so is either a low-pass-filtered, or a peaked signal, depending on whether or not the machine is in shuttle. When the output stage is muted and premute is selected on the control panel, the monitoring system switches to the premute signal so that the tape can still be listened to through the monitoring system. Since the premute signal is a fixed level, and the line output is whatever the line distribution level is, R229 is used to match the monitor system to the output signal level. For 0 vu level, R229 is adjusted for -8 dBu at pin 28.

In some installations, an attenuator is desired for the premute signal to allow listening to a tape in shuttle without overpowering monitor speakers. By cutting the trace between E17 and E18, the monitor system gain is dropped 10 dB whenever the PWA is switched to premute, eliminating this problem.

The metering circuit takes its input from the monitor output. The first stage, U44A, is an inverting adjustable gain for calibrating the meter. From here, the signal can take one of two paths as determined by U29-12, 13, 14:

1. From level control stage through a damping resistor to the meter, which then operates with vu ballistics.
2. From level control stage to a square-root stage, with dc filtering for PPM ballistics.

U44A is the common-level control stage for each, and should be adjusted so that the meter deflects to 0 vu (to the start of the red section in the vu mode, to center of meter scale in the PPM mode) when there is a unity level signal in the system (-8 dBu at pin 28). When in vu mode, Q63 and Q64 clamp the signal to the meter at about +,- 3V to protect meter movement.

When metering is switched to PPM, the signal to the meter is passed from U44A through U45. U45 is a dual OTA with full-wave rectifiers included internally. OTAs are connected to give a square-root transfer function. This signal is then rectified, with the resulting output taken from U44-16. This signal is buffered by Q79, and peak-held by C139, R305, and R306. This dc level, which represents the peak signal level, is buffered again by U46A, and passed on to the meter. C140, R311, R3q112, R313, and L10 form a peaking network so that a true vu meter can be used to produce a faster movement response time. Q78 shorts C139 and U29-12, 13,14 is disabled by U59 during power on to prevent meter movement from pinning whenever power is turned on.

U55A is used to drive peak LEDs on the control panel. The threshold is adjusted by applying R309 until the LED just turns on.

A relay in series with the output normally turns output off. After power has been applied, and circuitry has settled, U59-4 goes high, turning on Q70. This in turn causes Q75, Q76, and associated parts to pull the relay coil to ground for about 0.5 seconds to energize the relay, and then take the coil to a holding voltage of about 5V. This design reduces by half the power required for these relays.

7-22 Line Output Troubleshooting

If no differential signal is present at the output of the machine (either high out or low out) the first thing to check is the fuses on the outputs. If they are not blown, and there is a signal on the fuses but not on the output of the machine, then relay K2 is bad or the turn-on circuit for the relay is not functioning.

Line drivers themselves are similar to a typical hi-fi power amplifier, and as such can be traced through. In general, however, if a signal occurs at U32-7, a signal of some sort will occur on the output. Also note, however, that there are 2-amp fuses on the +,- 24V supplies which are located on the 24V regulator in the back card slot of the machine, and if either of these is blown, the line output stage will not work. Check for +,- 24V on the PWA extender card (+24 is at pin 10, -24 is at pin 9).

If no signal occurs at U32-7, check that U31-1 and U31-16 are at -11.4V. If this point is at -12 volts, output has been muted, and if it is at any other voltage, the OTA is dead. It should also be possible to check for a signal at U32-4 and U32-14 to ensure that U30 is functioning correctly. However, be advised that the signal is on the order of a couple of millivolts (depending on signal level, of course) so a sensitive probe must be used here. If playback is working to TP10, yet no output occurs, check relay K3.

U28-6, the monitor amp, should be near ground with no signal. If no signal appears when in EE (stop—not ready) then R229 may have been misadjusted, or U29 or U28 has failed.

If trouble exists in the metering circuit and U44-1 works, U45 may be faulty. When functioning correctly, signal at U45-16 should be a full-wave rectified signal whose peak amplitude is equal to the square root of the input amplitude. The full-wave rectified signal should be flat from 50 Hz to 20 KHz, and at any level, or else U45, C137, C1, 22, or C120 are dead. Also note that the signal at U46-3 is the dc-rectified voltage level of the peak signal at U45-16, with a time constant set by C139.

The rest of the circuitry consists of simple gain stages, and can be easily troubleshot.

7-23 Logic Circuitry

Most logic control lines are passed to the Audio PWAs by way of three serial data lines. These lines contain 16 recirculating bytes of data, each byte latched to the PWA at bias frequency rate. Lines DC (pin 54), DE (pin 49), and DA (pin 53) are data lines. D (pin 50) is the data clock, with hold (pin 46) and the strobe (pin 58) also used to ensure correct clocking. The sequence is as follows: D is eight pulses long, followed by a four-clock period wait during which time hold goes high. Since each of the possible four channels of audio is addressed in turn, the audio strobe (pin 58) goes high only when the audio channel being addressed has good data on it. For instance, if the PWA is plugged into the Audio 1 channel slot (card slot 8), then the strobe line only goes high when the PWA has received data for audio channel 1.

DA also contains a PWA address on bits D6 and D7 of the byte. These two bits are compared with two bits that change, depending on which slot the card is inserted into (pins 61 and 62 which are: 00 for audio one, 01 for audio 2, etc), and they must match for data to be latched by the PWA. In this way, three things have to be correct (PWA address, hold line, and strobe) in order for the PWA to accept anything from the serial data, thus making it nearly impossible to clock in the wrong data.

DA also contains basic logic commands. Record, erase, EE/Tape, and mute signals are clocked in by this data line. In addition, board address and record setup address information are also contained on this byte. The byte is converted from serial to parallel data using U49, and latched onto the PWA if it is correct by U58.

DE is converted to parallel data by U48, and latched by U57. This byte contains the following logic signals: Audio Processor on/off, A1 & A2 Mix, EBU/SMPTE equalization, monitor setup, monitor premute/post-mute, VU/PPM meter ballistics and shuttle.

Dc contains numbers used for record setup. The byte is converted to parallel data by U47, and latched by D/A converter U56. The D/A output is then level-shifted by U55, and passed to a demultiplex sample-and-hold stage consisting of U38, U20, U27, U37, and U21. In this way, each of the record setup parameters (i.e., record level, equalization, predistortion, and bias) is loaded in turn to the Audio PWA, sampled and held until the next byte of data is received. Sampled data is then low-pass-filtered, and passed on to the various OTAs that control record function level.

To troubleshoot this section, first trigger scope from the signal at U49-10 (or you can use TP6 on the Audio Control PWA). This is the lowest clock frequency available in the system. DA, DE, and DC should then appear as 16 recirculating bytes. From this point it can be seen that the hold-and-strobe signals are being sent correctly, and that D is being clocked correctly. Here, check that each of the serial-to-parallel converters (the CD4015s) is working correctly, and that data is being latched into the correct places. Voltage level out of the D/A stage (at U55-7) should vary from 0.6V to 5.0V, depending on position of the appropriate record level control, but in any case should be four independent voltage levels for each of the functions on this PWA.

7-24 Audio Control PWA, A12, Assembly No. 1467120

The Audio Control PWA occupies position 12 in the VPR-3 electronics bay. A simplified block diagram of the Audio Control PWA is provided in Figure 7-5. A more detailed block diagram is given in Figure 7-6. The primary function of this PWA is to provide an interface between the transport control logic and the audio and video systems. Other functions include: reading off-tape playback signal, generating test tone frequency and audio system clocks, controlling video, sync, and control track erase heads, and providing audio monitoring switching.

Audio record and setup data, as well as various video subsystem commands, are input to the Audio Control PWA via the system data bus (D BUS 0-7). Bus data is then decoded and routed to individual PWAs. In the case of decoded video commands, data is latched and transmitted directly to the video subsystem.

Incoming audio control and monitoring setup data is decoded and presented to the Audio PWAs as two 16-word recirculating serial strings (DA and DE, respectively). Audio record setup parameters, generated by the transport control logic, are decoded and loaded into the Audio Control PWA's 16 x 8 RAM via the H BUS (0-7). During automatic tape optimization, stored setup parameters are recalled from the RAM and presented to the Audio PWAs as a third 16-word serial string DC. With the VPR in manual optimization mode, tape setup values for each Audio PWA are set using potentiometers located on the forward edge of the Audio Control PWA. Potentiometer values are digitized, stored, and sent to the Audio PWAs via the dc serial string. Each Audio PWA is addressed sequentially, beginning with Audio 1 and ending with the optional Audio 4 PWA.

The RAM can be addressed by either transport control logic (D0-7) or by an on-board counter, which generates a series of sequential addresses. Both sources address the RAM via the 4-bit J BUS (J0-3).

Off-tape-level feedback circuitry allows the playback signal to be read by transport control logic. Desired audio output is selected by the transport control microprocessor, and is then digitized by feedback circuitry. This digital signal, representing peak playback signal level of the selected audio channel, is then placed on the system data bus for transmission to the transport control logic. The Audio Control PWA contains the audio system master oscillator. This oscillator and its supporting circuitry generate timing pulses used to address individual Audio PWAs (AUDIO STROBE 1-4), to clock in the serial string data (0D), and to provide timing signals for the control track, video, and sync erase heads (298 kHz). Additionally, the oscillator outputs a pair of switch-selectable signals used to clock the test tone generator.

The test tone generator produces a distortion-free test tone, used by the audio system during the automatic tape optimization process. Depending on the clock frequency selected from the master oscillator, the test tone will be either 1 or 10 KHz. The test tone may be set to either 0 vu (for normal testing) or to +8 vu (for predistortion).

Erase current control is provided for control track, video, and sync erase heads. Individual erase currents are held constant via a pair of feedback loops, which compensate for the effects of various operating conditions, such as crosstalk produced when an adjacent erase head is turned on. On-board adjustments allow circuitry to be phase-matched, and erase current levels set.

Audio monitoring circuitry allows monitor inputs to be selected from individual channels of either input or output audio. Additionally, the right or left speaker may be designated as the monitor for a selected channel. Switching control is supplied by the transport control logic.

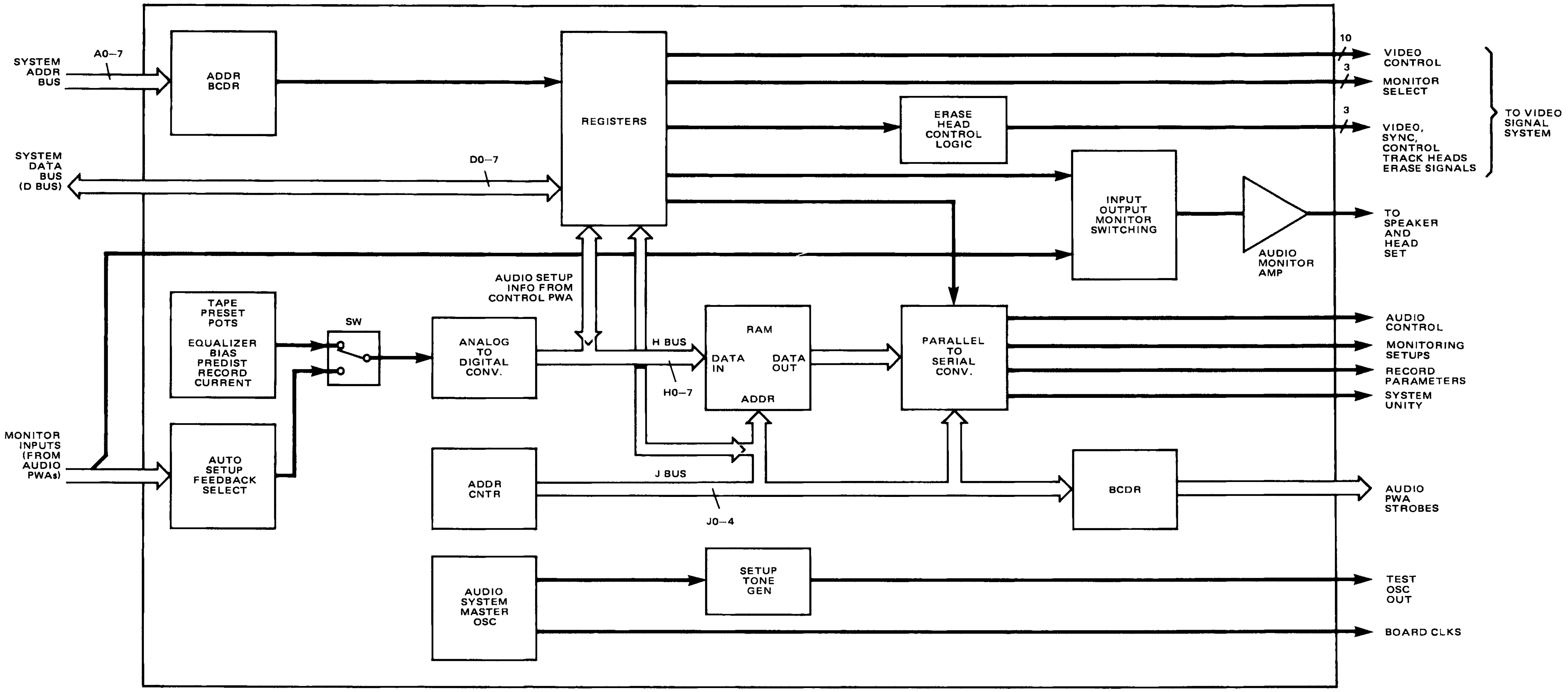
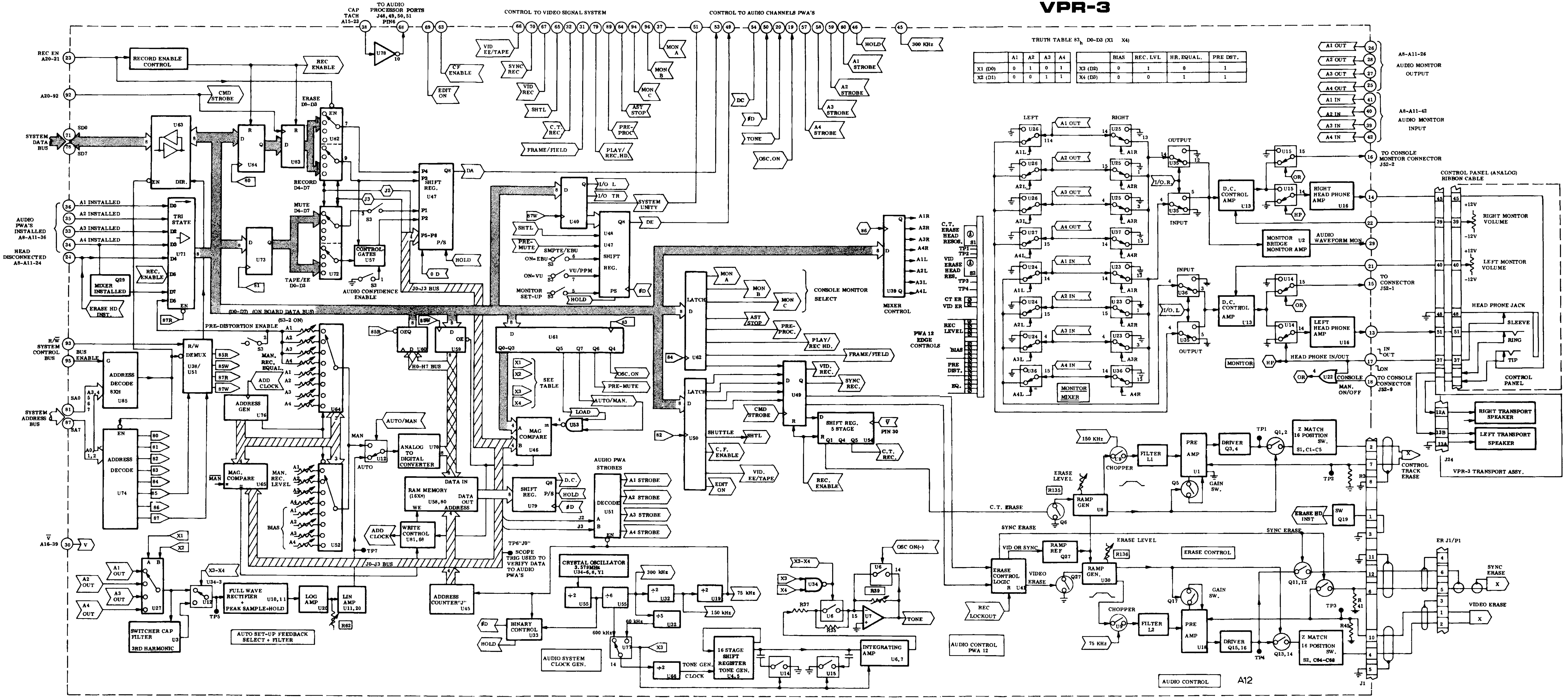


Figure 7-5.
Audio Control PWA 12 Simplified Block Diagram



TRUTH TABLE 83_h D0-D3 (X1 X4)

	A1	A2	A3	A4
X1 (D0)	0	1	0	1
X2 (D1)	0	0	1	1

	BIAS	REC. LVL	HR. EQUAL.	PRE DST.
X3 (D2)	0	1	0	1
X4 (D3)	0	0	1	1

Figure 7-6.
Audio Control PWA 12
Detailed Block Diagram

The Audio Control PWA performs the following functions:

1. Decodes system bus for signal system.
2. Converts main record information from system bus and J BUS address into a recirculating string of 16 serial words, which are sent to the four Audio PWAs.
3. Converts audio setup information from system bus into a recirculating string of 16 serial words, which are sent to the four Audio PWAs.
4. Converts Audio PWA's analog response to audio setup information into an 8-bit word, which is written to the system bus.
5. Converts miscellaneous audio information from system bus into a recirculating serial data word, which is sent to the four Audio PWAs.
6. Outputs audio status to the bus.
7. Decodes system bus for audio monitor switching.
8. Provides assorted audio functions including:
    a. Reference audio frequency generator.
    b. Sine wave synthesizer for audio setup.
    c. Control track, video, and sync erase head driving circuitry.
    d. Signal processing circuitry for audio setup.

An important function of the Audio Control PWA is to decode commands from the system bus for the signal system. The Control PWA communicates with the Audio Control PWA by placing an address between 80H and 87H on the system address bus. U85 is the address decoder that enables bus communication circuitry on the Audio Control PWA.

U74 decodes individual addresses for the Audio Control PWA; e.g., U74 pin 15 (Y0) corresponds to address 80H, U74 pin 14 (Y1) = 81H, etc.

U63 and U51 buffer and control the direction of data to and from the system data bus. Several latches are dedicated to latching in data from the bus at a specific address.

Table 7-1 is the Byte Chart for the Audio Control PWA as it is written to by the Control System.

7-25 Address 82H and 84H

Data addressed to 82H and 84H contain, for the most part, video bits. Exceptions are 82H bit D1 the video erase bit, 82H bit D5 the CT (control track) record bit, and 84H bit D0 the sync erase bit, all of which are active high. The two erase bits are used to turn on the video bulk erase head, located between the scanner and the supply reel, and are on during any noninsert-type recording when the correct video

Table 7-1. Audio Control PWA Byte Chart

Hex Address	Bits of Byte							
Hex	D7	D6	D5	D4	D3	D2	D1	D0
80hex	A4	A3	A2	A1	A4	A3	A2	A1
	Record (high on)				Erase (high on)			
81hex	Mute (low is audio muted)				Tape (high) /EE (low)			
82hex	Sync Record	Editor on/off	C.T. Record	Video Record	Video T/EE	Shuttle	Video Erase	C.F. Enable
83hex	Auto/Man	Premute	Load	Osc. On/off	X4 set-up	X3 function	X2 Address	X1
84hex	C Waveform Monitor Sel.	B	A	AST Variable	Video Prepro	Play/Rec Head Sel	Frame/ Field	Sync Erase
85hex Audio-Mixer-	MSB.							LSB
	BST/CUT MSB-(H.P. Filter) -LSB				BST/CUT MSB- (L.P. Filter) -LSB			
Write-	Auto set-up level information sent to the Audio System							
Read-	Off-tape level information for use during Auto Set-up							
86hex	A4	A3	A2	A1	A4	A3	A2	A1
	Left Channel of Audio Monitor				Right Channel of Audio Monitor			
87hex Read-	Mixer instal.	Master Rec. LO	Pre-dist enable	Head discon.	A4	A3	A2	A1
						Pwa installed in system (low).		
87hex Write-	Audio 1&2 Mix	Proc Proc	Open	System Unity			Left input	Right monitor

channel has also been enabled. Since this head is located about 1 second ahead of the scanner, on and off timing is not at all critical, so for convenience, they are timed as though they were audio erase heads. The CT (control track) record bit also toggles CT erase, and because of the unique way in which the CT is turned on and off, a delayed CT record signal is sent by the audio control PWA to the CT/Capstan Servo PWA, so the control system need not time both CT record and CT erase signals. This arrangement, however, does not allow for exact entrance and exit points, so the CT record bit is turned on a few msec ahead of the audio erase on and off, and a few msec after audio erase off to make an approximately timed insert edit. All these bits are also double-buffered by the Go command strobe. They load the same way as 80H. 82H bit D4 (video record) and bit D7 (sync record) are also double buffered. Every record and erase signal in the VPR-3 is turned on and off by a strobe independent of software or machine code, and thus edit timing is much more precise. The data latch for audio address 82H (video bus) is U50. Several of the signal system commands are not updated until the Audio PWA receives a command strobe from the Control PWA. U49 is the latch for these signals.

Output pins on U50 correspond to commands as indicated in Table 7-2.

The data latch for audio address 84H (monitor control) is U62. Output pins on U62 correspond to commands as indicated in Table 7-3.

Table 7-2. U50 Commands

Data Bit	U50 Pin No.	Command Name
0	2	COLOR FRAME ENABLE (+)
1	5	VIDEO ERASE (+) (Buffered and latched by U49)
2	6	SHUTTLE (+)
3	9	VIDEO TAPE (+)/EE (-)
4	12	VIDEO RECORD (+) (Buffered and latched by U49)
5	15	CT RECORD (+) (Buffered and latched by U49)
6	16	EDIT ON (+)
7	19	SYNC RECORD (+) (Buffered and latched by U49)

Table 7-3. U62 Commands

Data Bit	U62 Pin No.	Command Name
0	2	SYNC ERASE (+) (Buffered and latched by U49)
1	5	FIELD (+)/FRAME(-)
2	6	PLAY HEAD (+)/RECORD HEAD(-)
3	9	PRE-PROCESSING
4	12	STOP
5	15	VIDEO MONITOR SWITCHING A
6	16	VIDEO MONITOR SWITCHING B
7	19	VIDEO MONITOR SWITCHING C

7-26 Address 80H

The data latch for audio address 80H (record and erase commands) is U84. Output pins on U84 correspond to commands as indicated in Table 7-4. U83 latches in the above command status when it receives a command strobe from the Control PWA.

Table 7-4. U84 Commands

Data Bit	U84 Pin No.	Command Name
0	2	A1 ERASE (+)
1	5	A2 ERASE (+)
2	6	A3 ERASE (+)
3	9	A4 ERASE (+)
4	12	A1 RECORD (+)
5	15	A2 RECORD (+)
6	16	A3 RECORD (+)
7	19	A4 RECORD (+)

7-27 Address 81H

In audio byte 81H, bits D0 through D3 are for tape (high)/EE (low) switching, and D4 through D7 are mute signals (active low), both operating on Audio 1 through Audio 4, respectively. Tape/EE is changed by pushing the control panel switch in any machine mode except play, when it is jammed to tape. In normal operation, the function will self-toggle to tape when the machine enters play, jog, shuttle, variable play, TSO (tape speed override), and ready. It will toggle to EE when the machine enters record or stop-not-ready. In any mode except play, the function can be toggled to the other state by pushing the Tape/EE switch on the control panel. When one or more audio channels are inhibited while others are in record, the inhibited channels are in play and jam to tape, while the recording channels follow the Tape/EE switch as described above. For the mute bits, audio outputs are enabled (mute high) when the VTR is in stop-not-ready, play, record, and TSO. In all other machine modes, outputs are muted. Since it takes the transport only 20 msec to come to full play speed, audio is muted for about six video fields upon entering play (from any mode) so that the user will not hear off-tape audio as the transport comes up to speed. An independent mute signal for each channel allows these signals to be used independently for edit rehearsals.

The data latch for audio address 81H is U73. The output pins on U73 correspond to commands as indicated in Table 7-5.

Commands at the outputs of U83 and U73 are converted into a recirculating string of 16 serial words which is sent over serial line (DA) to the four audio PWAs.

Table 7-5. U81 Commands

Data Bit	U81 Pin No.	Command Name
0	2	A1 TAPE (+)/EE(-)
1	5	A2 TAPE (+)/EE(-)
2	6	A3 TAPE (+)/EE(-)
3	9	A4 TAPE (+)/EE(-)
4	12	A1 MUTE (-)
5	15	A2 MUTE (-)
6	16	A3 MUTE (-)
7	19	A4 MUTE (-)

The format for the 16 serial words is:

D8 (Audio PWA address-msb) D7 (Audio PWA address-lsb) D6 (setup function-msb) D5 (setup function-lsb) D4 (erase command) D3 (record command) D2 (Tape/EE command) D1 (mute command).

Bits D8 and D7 of serial word DA are the addresses of the Audio PWA for which the commands on D1-D4 of serial word DA are directed. See Table 7-6.

Table 7-6. Bits D8, D7 — Audio PWA Address

D8	D7	Audio PWA Address
0	0	AUDIO BD 1
0	0	AUDIO BD 2
1	1	AUDIO BD 3
1	1	AUDIO BD 4

Audio PWA connectors are hard-wired to determine the address of Audio PWAs (i.e., board no.); the serial-to-parallel converter on individual Audio PWAs will only decode commands for their address.

The Audio Control PWA uses three buses—the D bus, the H bus, and the J bus. The D bus, which is the system data bus, is active on the Audio Control PWA when the system address bus on the inputs of U85 and U74 has an address between 80H-87H on it.

The H bus is the Audio Control PWA data bus for two types of data. The first type is audio setup information from the Control PWA. The second type is the selected Audio PWA's feedback information which tells the control system the Audio PWA's response to setup information it received. The system data bus is latched and buffered by U59, then fed to data inputs of RAM chips U58 and U80. A-to-D Converter U70 places an 8-bit word on the H-Bus that represents the selected Audio PWA's response to setup information it received. This information is latched into U60, which places it onto the system data bus when enabled.

The J bus is an internal four-line address bus. The J bus provides address lines for RAM chips U58 and U80, and is the parallel input on lines P5 through P8 of shift register U47. Shift register U47 generates serial word DA, which has main record commands and J bus address encoded in its bit pattern. The J bus address, decoded from serial word DA by the individual Audio PWAs, identifies which Audio PWA is selected and which setup function is active. The J bus selects which Audio PWA record commands will be sent out, along with J bus address, on the serial word being sent on line DA. For example, if the J bus is at XX00b, the A1 erase command on the 1C0 input of 4 x 1 line selectors U82 (U82-6) will be placed at the P4 input of shift register U47. Table 7-7 indicates the setup function established by the J bus.

Table 7-7. J Bus Address and Selected Record Setup Function

J Bus Address	Audio PWA Selected	Setup Function
0000b	Audio 1	Bias
0100b	Audio 1	Record level
1000b	Audio 1	Equalization
1100b	Audio 1	Predistortion
0001b	Audio 2	Bias
0101b	Audio 2	Record level
1001b	Audio 2	Equalization
1101b	Audio 2	Predistortion
0010b	Audio 3	Bias
0110b	Audio 3	Record level
1010b	Audio 3	Equalization
1110b	Audio 3	Predistortion
0011b	Audio 3	Bias
0111b	Audio 3	Record level
1011b	Audio 3	Equalization
1111b	Audio 3	Predistortion

Note

J Bus J0 and J1 select the Audio PWA and J bus J2 and J3 select audio setup function.

7-28 Address 83H and 85H

The audio system auto setup feature works through 83H and 85H. 83H contains address information to tell the audio system what to do, while 85H is a read/write byte that contains level-related information. For example, if the control system writes 1X110000 to 83H, it is telling the audio system that it is in automatic setup mode optimizing record level for audio one. This byte then controls the Audio Control PWA to load the number written at byte 85H into a 16 byte RAM on the Audio Control PWA. It also directs the audio system to look at Audio 1 playback level from the monitor head, convert that signal to a digital word, and make it available through 85H read. The 16-byte setup RAM is constantly read by the Audio Control PWA, with level bytes downloaded to the Audio PWAs.

83H D0 through D3 contain setup address information for the audio system. D0 and D1 are the audio channel address (in the order D1, D0-00 is for audio 1, 01 is for audio 2, 10 is for audio 3, and 11 is for audio 4/mixer) and D2 and D3 are for the setup function (in the order D3, D2-00 is for bias, 01 is for record level, 10 is for equalization, and 11 is for predistortion). In auto setup, D0 through D3 address the off-tape monitor demultiplexer input to an A/D converter, as well as the setup function storage RAM address. D4, D5, and D7 of 83H control the audio setup functions. D4 is oscillator on (active high), D5 is load (active high), and D7 is auto (high/man (low). When all three bits are at their reset state (83H is 0X00XXXX) the system is in manual operation, and control of record parameters is passed to potentiometers on the edge of the Audio Control PWA. When auto/man is brought high (83H is 1X00XXXX), whatever setup values were loaded in the setup RAM (in this case, the manual levels) stay there, and the PWA is put into a talkback mode. In this mode, anything written into 85H can be read right back for diagnostics. If load is also brought high (83H is 1X10XXXX), then anything written into 85H is loaded into the setup RAM and also sent on to Audio PWAs, with its write address being 83H D0 through D3. In this mode, different setup values can be downloaded from the control system without having to go through the auto setup function. If oscillator is also brought high (83H is now 1X11XXXX), auto setup has been entered, and the off-tape read function through 85H has also been enabled. If D4 is high, D5 is low, and D7 is low (83H is 0X01XXXX), then manual setup mode is entered for use in setting up the machine using card potentiometers on the Audio Control PWA. In this mode, D7 is strobed high (83H becomes 1X01XXXX) for two video fields to read the off-tape level in 85H, and that level is shown on a bar graph in the display. When the control system is downloading any information to the audio system, the address (83H D0 through D3) changes only when the load bit is low, and then load is strobed high for at least one video field to lead the data. (Note that for 83H, 0X1XXXX is the only invalid state.) Bit D6, which is pre-mute. This signal is active low only when the audio has been muted in all or in part, and the pre-mute function has been selected on the control panel.

Setup of the Audio Mixer PWA is slightly different than for a normal audio channel. Since only a simple bass and treble control exists on the mixer for each input channel, the level byte (85H) is split into two nibbles. D0 through D3 are used for the low-pass filter, and D4 through D7 are used for the high-pass filter. The number 1000 in each of these nibbles is center, with boost available by increasing the number, and cut available by decreasing the number. The address for the channels of filtering is handled by 83H D2 and D3 (00 for audio 1, 01 for audio 2, 10 for audio 3, and 11 for mixer external input).

The data latch for audio address 83H (setup register) is U61. Output pins on U60 and U61 correspond to commands as indicated in Tables 7-8 and 7-9.

Table 7-8. U60 Commands

Data Bit	U60 Pin No.	Command Name
0	2	Audio PWA address 1sb
1	5	Audio PWA address 1sb
2	6	Audio setup function 1sb
3	9	Audio setup function msb
4	12	Test osc on (+)
5	15	LOAD (+) A high on this bit and bit 7 enables a write operation to audio control PWA RAM of data on the H Bus.
6	16	Pre-mute (-)
7	19	Auto audio setup (+)/Man audio setup (-)

Table 7-9. U61 Commands

Data Bit	U61 Pin No.	Command Name
0	2	Audio PWA address 1sb
1	5	Audio PWA address 1sb
2	6	Audio setup function 1sb
3	9	Audio setup function msb
4	12	Test osc on (+)
5	15	LOAD (+) A high on this bit and bit 7 enables a write operation to audio control PWA RAM of data on the H Bus.
6	16	Pre-mute (-)
7	19	Auto audio setup (+)/Man audio setup (-)

The data latch for audio address 85H Write (Write Audio setup register) is U60. This latch contains setup information from the Control PWA for the Audio PWA, addressed by D0 and D1 of address 83H. Bits D2 and D3 of address 83H identify the audio setup function.

The data latch for audio address 85H Read (Read Audio setup register) is U60. This latch contains the Audio PWA response to setup information input to it by the 85H Write data.

System bus addresses 83H and 85H work together to transfer audio setup information between control system and audio system. The first four data bits of bus address 83H are used as an address for audio setup information. The audio setup word from the control PWA is placed into U59 by writing to system address 85H. The audio PWA response to the audio setup word from the control PWA is read from latch U60 by doing an address 85H read.

The data latch for address 83H is U61. The first four data bits are the address of the 8-bit word that is latched into U59. Events that take place during the loading of an 8-bit word for Audio PWA 1 bias setup are as follows: First, the Audio PWA 1 bias setup information is written into latch U59. This is done by writing the Audio PWA 1 bias setup information to system bus address 85H. Second, 1X1X0000b is written to address 83H, which causes outputs Q0 through Q3 on latch U61 to go low. These feed into comparator U46-B0 through B3 inputs. Outputs Q5 and Q7 of U61 are high, which enables comparator U46.

When the J bus lines that feed lines A0-A3 inputs on comparator U46 match the B0 through B3 inputs, which are the D0-D3 bits of address 83H, the comparator output U46-6 goes high. When U46-6 goes high, the write enable pin on 16 x 4 bit RAM chips U58 and U80 is pulled high and then data at their input (H bus) is written into location 0000b (J bus).

Audio setup information is continuously read from RAM and placed on parallel inputs of shift register U79, which sends a recirculating string of 16 serial words of audio setup information on the serial line DC. The address (Audio PWA and setup function) of each serial word is contained in bits D5-D8 of the 16 serial words on serial line DA. Audio PWAs decode the two serial lines (DA and DC) to extract setup information. The signal used to indicate the start of each data string is the HOLD signal on pin 50, the clocking signal for the data strings is V0d (pin 46). Individual Audio PWA addresses are determined by motherboard wiring. J Bus HOLD and V0d signals are all derived from the reference audio frequency which is generated by U34 and assorted components.

If bit D7 of address 83H is low (manual audio setup, U61-19) then audio setup information is derived from potentiometer controls on the edges of the Audio Control PWA instead of the bus.

Circuitry that converts potentiometer voltages into an 8-bit audio setup word which is loaded into the RAM chips U58 and U80 comprises 8 x 1 analog switches U52 and U64, manual setup addressing circuitry U76, U64, U81, and A/D converter U70.

This Audio Control PWA converts miscellaneous audio information from bus into a recirculating serial data word which is sent to the four Audio PWAs. Serial line DE, which comes out of shift register U48, has miscellaneous commands encoded into its single recirculating serial word. These commands come from various sources; commands and their sources are listed in Table 7-10.

Table 7-10. Serial Word DE

Serial Bit No.	Source	Function
D1	U61-16 (address 83H D6)	Premute (-)
D2	U50-6 (address 82H D2)	Shuttle (+)
D3	switch 3 section 7	VU (+) /PPM (-) METER
D4	switch 3 section 5	MON SETUP (+)
D5	switch 3 section 6	EBU (+) /SMPTE (-) EQ
D6	U40-19 (address 87H WRITE D7)	MIX (+)
D7	U40-16 (address 87H WRITE D6)	PROC (+)
D8	U40-15 (address 87H WRITE D5)	Spare

7-29 Address 87H

87H byte works in both write and read mode. In write, D0 and D1 are for audio input monitoring (right and left channels, respectively). They follow control panel switches like the monitor select switches above, but operate in a push-on push-off fashion. D4 write is for system unity (active high), also a push-on push-off control panel switch. D6 write is audio processor enable, and D7 is Audio 1&2 Mix, both are active high and toggled by soft keys. D5 write is an uncommitted bit which is passed to the Audio PWAs.

87H read is used for audio system status. D0 through D3 and D7 are PWA-installed signals (low is installed) for Audio 1 through Audio 4 and Mixer, respectively. D6 is the master record lockout bit (low is lockout), D4 is audio head disconnected (low is disconnected), and D5 is predistortion enable (active low). Master record lockout clears record and erase buffers on the Audio Control PWA and in the control system. If machine enters play, record, ready, or TSO, and the audio head disconnected signal is low, then a prompt appears in the display to tell the user this fact. If predistortion is inhibited, then all predistortion level bytes are cleared, and are ignored during auto setup. This byte is read periodically, and the control system updates itself accordingly (i.e., if an Audio PWA is withdrawn from the machine, its record status LEDs go off, etc.).

The data latch for audio address 87H WRITE (audio control register) is U40. Output pins on U40 correspond to commands, as indicated in Table 7-11.

U71 is used to output audio system status to the bus. U71 is the data latch for address 87H READ (audio fault register). U71 output pins correspond to audio system status as indicated in Table 7-12. Data latch U39 determines which audio channel goes to the right monitor channel, and which audio channel goes to the left monitor channel.

Table 7-11. U40 Commands

Data Bit	U40 Pin No.	Command Name
0	2	Audio monitor right input (+)
1	5	Audio monitor left input (+)
2	6	Not used
3	9	Not used
4	12	System unity (+)
5	15	Not used
6	16	Proc on (+)
7	19	MIX (+)

Table 7-12. U71 Commands — Address 87H READ (Output Port to Bus)

Data Bit	U71 Pin No.	Command Name
0	2	Audio 1 pres (-)
1	5	Audio 2 pres (-)
2	6	Audio 3 pres (-)
3	9	Audio 4 pres (-)
4	12	Head disconnect (-)
5	15	Predistortion enable (+)
6	16	Rec enable (+)
7	19	MIXER (-)

Analog switches U25, U26, and U37 select which output audio monitors will be fed into analog switch U35 inputs U35-4 and U35-14.

Analog switches U23, U24, and U36 determine which input audio monitor will feed the analog switch U35 input.

D0 and D1 bits of 87H WRITE are fed to line selection inputs of U35 (U35-9, 10, 11) and they determine whether input audio monitor or output audio monitor is fed to audio monitor drivers.

7-30 Address 86H

86H is the audio monitor select byte, and follows the control panel switches (high when LED is on). D0 through D3 are for left channel and D4 through D7 are for right channel; both channels activate Audio 1 through Audio 4/Mixer, respectively.

These eight switches operate like shadow-type switches—that is, what you push is what you get, allowing selection of one or more and possibly all audio channels in a monitor channel. The one exception to this operation is to allow a user to turn off a channel of monitoring completely. The user first selects only one audio channel in a channel of monitoring, and then pushes the selected channel a second time to turn it off.

The data latch for address 86H (audio monitor register) is U39 and its outputs are as indicated in Table 7-13.

Table 7-13. U39 Command — Address 86H

Data Bit	U39 Pin No.	Command Name
0	2	Audio 1 right (+)
1	5	Audio 2 right (+)
2	6	Audio 3 right (+)
3	9	Audio 4 right (+)
4	12	Audio 1 left (+)
5	15	Audio 2 left (+)
6	16	Audio 3 left (+)
7	19	Audio 4 left (+)

This PWA also provides a reference audio frequency generator, a sine wave synthesizer for audio setup, control track, video, and sync erase head driving circuitry, and signal processing circuitry for audio setup.

The reference audio frequency generator consists of crystal Y1, IC U34 and associated circuitry. Clock for the serial outputs DA, DC, and DE is divided-down reference clock (U55, U32 and U33 are the dividers). Clock for the sine wave synthesizer comes from U77-14, which switches between two divided-down reference clock frequencies. Clock for the three erase drivers comes from U19-13.

The sine wave synthesizer consists of the sine wave generating circuitry U66, U4, and U5 and variable low-pass filter U4, U15, U6 and U7 pins 5, 6, 7.

IC U27 is a 4 x 1 audio switch that selects one of the output audio monitor channel's inputs for signal processing. Which channel U27 selects is determined by inputs A and B, which are in turn determined by the status of 83H bits D0 and D1. The actual signal processing operation is determined by the status of bits D2 and D3 of 83H, which are fed into inputs of NAND gate U34. If the audio setup operation is bias, record level, or equalization, then the selected output audio monitor channel is routed from the input of U27 to the input of a full-wave rectifier circuit U10 and U11, where it is rectified to determine its amplitude and then is fed to A/D converter U70, where it is converted to an 8-bit word for transmission on the system data bus. If the audio setup operation is predistortion, the output audio monitor channel is routed to the notch filter U3 for processing before being sent to A/D converter U70.

The audio control system byte chart is given in Table 7-1. 80H is the record byte, with D0 through D3 being erase bits and D4 through D7 being record bits. The byte is active high and the bits are assigned to Audio 1 through Audio 4, respectively. The byte is double-buffered by the Go Command Strobe. This means that first one buffer is written to by the control system bus, and then, upon receipt of the Go command strobe, the byte is passed on to the audio system. Record and erase signals are functions of on and off, ramped at different rate because there is a 100-msec time displacement between the record/play head and the erase head. During an insert edit, the erase on signal is applied about 88 msec before the entrance. The off signal begins about 112 msec before exit of the edit. Since exact timing is transport-dependent, an independent adjustment is available for entrance and exit points for both record and erase signals.

7-31 Audio System Monitoring

A block diagram of the audio system monitoring system is shown in Figure 7-7.

7-32 JUMPERS AND TEST POINTS

Jumpers used on the Audio PWAs are listed in Table 7-14.

Table 7-14. Audio PWA Jumpers

Jumper	Function	
J1:	Audio Head Connector	
J2:	VU Meter Selection	
	E20-E21	VU
	E20-E22	PPM
J3:	VU Meter Selection	
	E23-E24	VU
	E24-E25	PPM
J4:	Time-Code Equalization	
	A-B	Normal
	B-C	Time Code
J5:	Crossstalk Cancellation	
	A1, 2	PWA in Card Bay Position 8 or 9
	A3, 4	PWA in Card Bay Position 10 or 11
S1:	Erase Head Resonating Switch	

7-33 AUDIO PWA AND AUDIO CONTROL PWA EDGE CONTROLS

A list of test points provided on the Audio PWA is given in Table 7-15.

Test points provided on the Audio Control PWA are listed in Table 7-16.

Table 7-15. Audio PWA Test Points

Test Point	Signal
TP1	Erase Drive
TP2	Bias Trap
TP3	Record Driver Input
TP4	2nd Harmonic Null
TP5	10V Regulator
TP6	Record Input Level
TP7	Erase Current
TP8	Record Current
TP9	Bias Drive
TP10	Control Track Notch Filter
TP11	Playback Audio
TP12	Input Level

Table 7-16. Audio Control PWA Test Points

Test Point	Signal
TP1	Control Track Erase Drive
TP2	Control Track Erase Head Current
TP3	Video Erase Head Current
TP4	Video Erase Drive
TP5	Test Oscillator
TP6	Scope Sync J Bus to J0

Table 7-17 lists controls provided on the front edge of the Audio PWA and Audio Control PWA.

7-34 Audio System Alignment (SMPTE and EBU)

Three main adjustment categories are found in the VPR-3 audio system. The first involves the E-E signal path, the second is the playback signal path, and the third is the record/playback system.

E-E signal path adjustments depend on the value of the unity gain distribution level used at the facility where the VPR-3 is installed. Most often, this is +8 dBu. The VPR-3's audio system was set to operate at +8 dBu at the factory; however, at the time of installation at a facility using other than a +8 dBu audio distribution system, the VPR-3 should have been adjusted to match the facility's standard. Once set, E-E adjustments are designed to be stable and not require further adjustment. E-E path adjustments are given in paragraphs 7-39 through 7-46. These procedures

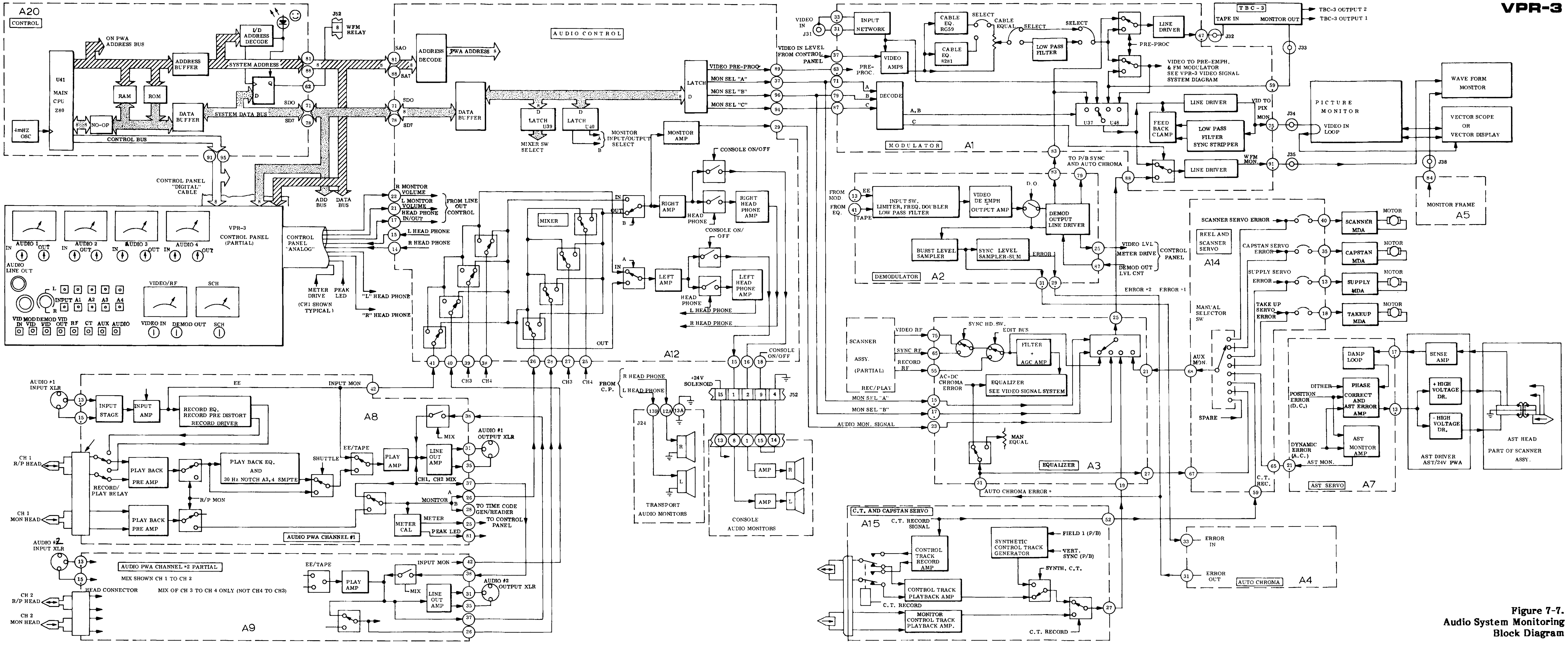
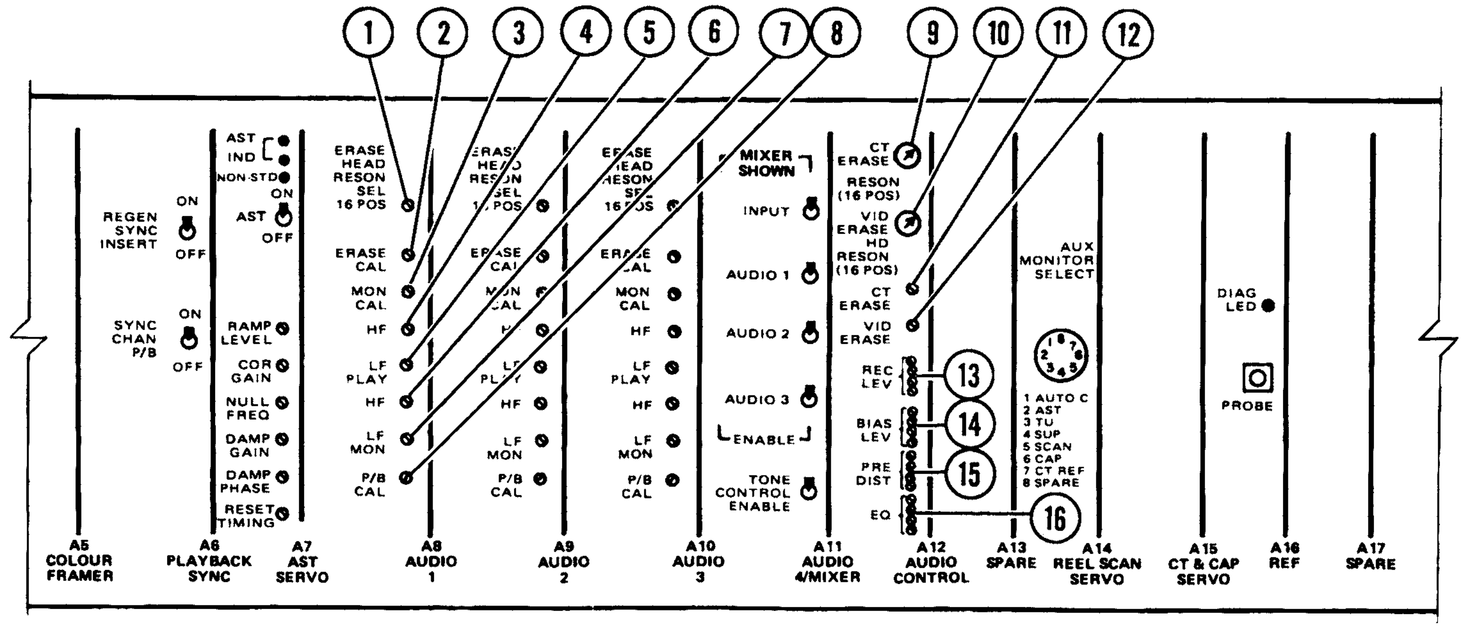


Figure 7-7.
Audio System Monitoring
Block Diagram

MOVED FROM
14 to 12

Table 7-17. Audio PWA and Audio Control PWA Edge Controls



Index No.	Description	Function
1	ERASE HEAD RESON. SEL 16-position switch S1	Optimizes audio erase channel by tuning erase head circuit for resonance with frequency of erase head drive current.
2	ERASE CAL potentiometer R102	Erase head current adjust control.
3	MON CAL potentiometer R207	Monitor head calibration control.
4	HF potentiometer R249	High-frequency playback equalization control.
5	LF PLAY potentiometer R250	Low-frequency playback equalization control.
6	HF potentiometer R319	Monitor head high-frequency equalization control.
7	LF MON potentiometer	Monitor head low-frequency equalization control.
8	P/B CAL potentiometer R329	Playback calibration control.
9	CT ERASE RESON 16-position switch	Optimizes control track erase channel by tuning erase head circuit for resonance with frequency of erase head drive current.
10	VID ERASE HD RESON 16-position switch	Optimizes video erase channel by tuning erase head circuit for resonance with frequency of erase head drive current.
11	C.T. ERASE potentiometer R135	Adjusts level of erase current supplied to control track erase head.
12	VID ERASE potentiometer R136	Adjusts level of erase current supplied to video erase head.
13	REC LEV 4 potentiometers R137-R140	There are four controls in the REC LEV group Each controls record level in one of the four audio channels. The topmost control adjusts audio 1 channel; the controls below adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.
14	BIAS LEV 4 potentiometers R177-R180	There are four controls in the BIAS LEV group. Each controls bias level in one of the four audio channels. The topmost control adjusts audio 1 channel; the controls below adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.
15	PRE DIST 4 potentiometers R192-R195	There are four controls in the PRE DIST group. Each controls predistortion level in one of the four audio channels. The topmost control adjusts audio 1 channel; the lower controls adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.
16	EQ 4 potentiometers R202-R205	There are four controls in the EQ group. Each controls playback equalization in one of the four audio channels. The topmost control adjusts audio 1 chan-nel; the controls below adjust audio channels 2, 3, and 4. These controls can be set from the Preset Setup menu.

need be repeated only when an Audio PWA or other component likely to affect the E-E path has been repaired or replaced. In addition, these procedures can be used in a check of overall audio system performance, and as an aid to troubleshooting.

The second adjustment category is the playback signal path, which is also designed to be stable, but as heads wear, adjustments must be made to compensate. Procedures for checking and adjusting the playback signal path are given in paragraphs 7-47 through 7-50. These checks need to be repeated periodically as the heads wear, and when a repaired or replacement Audio PWA or other component likely to affect the playback path has been installed. In addition, these procedures can be used in a check of overall audio system performance, and as an aid to troubleshooting.

The third category of adjustment involves the record/playback signal system. Each type of video tape used in recording on the VPR-3 requires that the VPR-3 provide a unique set of record parameters to assure optimum playback quality. An automatic record/playback optimization system with the capacity to generate/use and store/recall optimum record/playback parameters for as many as three tape types is built into the VPR-3. In addition, parameters for a fourth tape type can be set via potentiometers provided on the front edge of the Audio Control PWA. Procedures for generating, using, and storing a set of four optimum record/playback parameters for up to four tape types are given in paragraphs 7-51 through 7-64. New record/playback parameters must be set up and stored whenever a new tape type is used for recording on the VPR-3. In addition, new sets of record/playback parameters should be stored whenever an Audio PWA or other component likely to affect the record/playback path has been repaired or replaced.

The following paragraphs contain test and alignment procedures for ensuring proper audio system operation. Test procedures can be used to check overall audio system performance. If tests are satisfactory, alignment procedures need not be performed.

Alignment procedures are presented step by step in serial form for alignment of one channel. After you have become familiar with the procedures, you may choose to perform steps in parallel for each channel. Also note that because of the capacitive effect of extender board traces, the extender board is not used while making some adjustments.

Before performing the audio signal system alignment procedures, clean and demagnetize the head and other tape path components as described in this manual's preventive maintenance section. Capstan servo, scanner servo, and control track systems must be operating properly, and tape tension and torque values must be correct. Verify that tape-edge damage does not occur.

Note

Zero dBm is defined as a power level of 1 mW flowing into a 600-ohm resistive load. Units of dBm cannot correctly be used to describe a voltage level. For this reason, the term dBu is used in these procedures. Zero dBu is defined as 0.773 VRMS, which is the voltage

measured across a 600-ohm resistor when 0 dBm is applied to it. The conversion between the two terms is simply a matter of changing the dBm to a dBu. The raw number is equal in both cases. Units of dBu are correct to use when discussing voltage distribution systems.

After audio system alignment, ensure that setup switches (sections of the eight-section switch S3) on the Audio Control PWA are reset to the correct positions. The location of switch S3 is shown in Figure 7-8.

Refer to Table 7-18 for a list of the switch sections and their functions. Normal settings for these switches are indicated in Table 7-19.

Table 7-18. Functions of Audio Control PWA Switch 3

Switch S-3 Section	Function
S3-1	Audio Confidence is enabled when ON. When OFF, audio system is jammed to EE in record. Confidence head is automatically enabled when in a record setup mode.
S3-2	Predistortion enabled when ON.When OFF, predistortion functions are inhibited in all audio channels.
S3-3	Muting enabled when ON. When OFF mating is disabled.
S3-4	Not used.
S3-5	Confidence head setup. Normally OFF. When ON, audio confidence playback head is used for playback at all times.
S3-6	SMPTE/EBU equalization. When OFF, machine is in SMPTE equalization mode. When ON, machine is in EBU equalization mode.
S3-7	VU/PPM metering. When ON, VU metering is selected. When OFF PPM metering is selected.
S3-8	Not used.

Table 7-19. Audio Control PWA 12 Switch 3 Normal Switch Setting

Switch	Function	Switch	Function
S3-1	On	S3-5	Off
S3-2	On	S3-6	If SMPTE, off; if EBU, on
S3-3	On	S3-7	If VU, on; if PPM, off
S3-4	Don't care	S3-8	Don't care

7-35 Control Track Erase Head Current Adjustment and Video and Sync Erase Head Current Adjustment

Controls are provided on the front edge of the Audio Control PWA to adjust erase current supplied to the control track erase head and the sync and video erase head.

Erase head current adjustment procedures are given in the following paragraphs.

7-36 Control Track Erase Head

Adjust control track erase head current as follows:

STEP 1 With VPR-3 in record mode, simultaneously monitor waveforms at TP1 and TP2 while adjusting rotary switch S1 (CT ERASE RESON) on front of Audio Control PWA. Observe a clean sine wave at TP2 and a sine wave having crossover distortion at TP1. As rotary switch S1 is adjusted, signal at TP1 will change significantly; signal at TP2 will vary to a lesser degree. Correct adjustment for switch S1 is indicated when the two signals are in phase with each other. At this point, crossover distortion in the signal at TP1 occurs near the 0V point of the sine wave, and signal amplitude at TP1 is at a minimum. Any one or any combination of these signal characteristics can be used as criteria for correct adjustment of switch S1.

STEP 2 With the VPR-3 in record mode, adjust potentiometer R135 (CT ERASE potentiometer screwdriver adjustment) for 5 Vp-p at TP2; this produces 250-mAp-p erase current in the control track erase head circuit.

7-37 Sync and Video Erase Head Current Adjustment

Adjust sync and video erase head current as follows:

STEP 1 With the VPR-3 in record mode, simultaneously monitor waveforms at TP3 and TP4 (see Figure 7-8) while adjusting rotary switch S2 (VD ERASE HD RESON, on front of Audio Control PWA). Observe clean sine wave at TP3 and a sine wave having crossover distortion at TP4. As rotary switch S2 is adjusted, the signal at TP4 will change significantly; the signal at TP3 will vary to a lesser degree. Correct adjustment for switch S2 is indicated when the two signals are in phase with each other. At this point, crossover distortion in the signal at TP4 occurs near the 0V point of the sine wave, and signal amplitude at TP4 is at a minimum. Any one or any combination of these signal characteristics can be used as criteria for correct adjustment of switch S2.

7-38 Audio Erase Head Current Adjustment

Adjust audio head erase currents as follows:

Note

Audio PWAs must not be on extender when these adjustments are made.

STEP 1 Connect oscilloscope channel 1 to TP7 on PWA 8 (Audio 1 PWA, see Figure 7-9).

STEP 2 Connect oscilloscope channel 2 to TP7 on PWA 9 (Audio 2 PWA).

STEP 3 Place VTR in record mode.

STEP 4 Adjust ERASE HEAD RESON SELECT 16 POS control (S1) on the front of PWA 8 and ERASE HEAD RESON SELECT 16 POS control (S1) on the front of PWA 9 to enable the two sine waves observed on oscilloscope (149 kHz) to be in phase and at maximum amplitude. Ignore crossover distortion.

STEP 5 Adjust ERASE control (R102) on the front of the Audio PWA 8 for a 4.5 Vp-p at TP7 of PWA 8.

STEP 6 Adjust ERASE control (R102) on the front of the Audio PWA 9 for 4.5 V p-p at TP7 of PWA 9.

STEP 7 Press A1 soft keys to take audio channel 1 out of record. Channel 2 should remain in record. Verify that signal at 9TP7 is at 4.5 Vp-p and there is no signal at 8TP7. If 9TP7 is not 4.5 Vp-p, adjust 9R102 for 4.5 Vp-p.

STEP 8 Press A1 and A2 soft keys to take audio channel 2 out of record and place channel 1 into record. Verify that signal at 8TP7 is at 4.5 Vp-p and there is no signal at 9TP7. If 8TP7 is not 4.5 Vp-p, adjust 8R102 for 4.5 Vp-p.

STEP 9 Repeat steps 7 and 8, and verify that when both channels are in record that erase signals at 8TP7 and 9TP7 are both 4.5 Vp-p or greater, and when only one channel is in record that erase signal for that channel does not go below 4.5 Vp-p.

STEP 10 If audio system is a three-channel system, adjust in accordance with steps 11 through 13. If audio system is a four-channel system, skip steps 11 through 13 and proceed directly to step 14.

STEP 11 Connect oscilloscope channel 1 to TP1 of PWA 10 (Audio 3 PWA) and connect oscilloscope channel 2 to TP7 of PWA 10.

STEP 12 Adjust HEAD RESON SELECT 16 POS control (S1) on the front of PWA 10 for the two sine waves to be in phase.

STEP 13 Adjust ERASE control (R102) on the front of the Audio PWA 10 for 4.5 V p-p at TP7 of PWA 10.

STEP 14 Connect oscilloscope channel 1 to TP7 on PWA 10 (Audio 3 PWA).

STEP 15 Connect oscilloscope channel 2 to TP7 on PWA 11 (Audio 4 PWA).

STEP 16 Place VTR in record mode.

STEP 17 Adjust ERASE HEAD RESON SELECT 16 POS control on the front of PWA 10 and ERASE HEAD RESON SELECT 16 POS control on the front

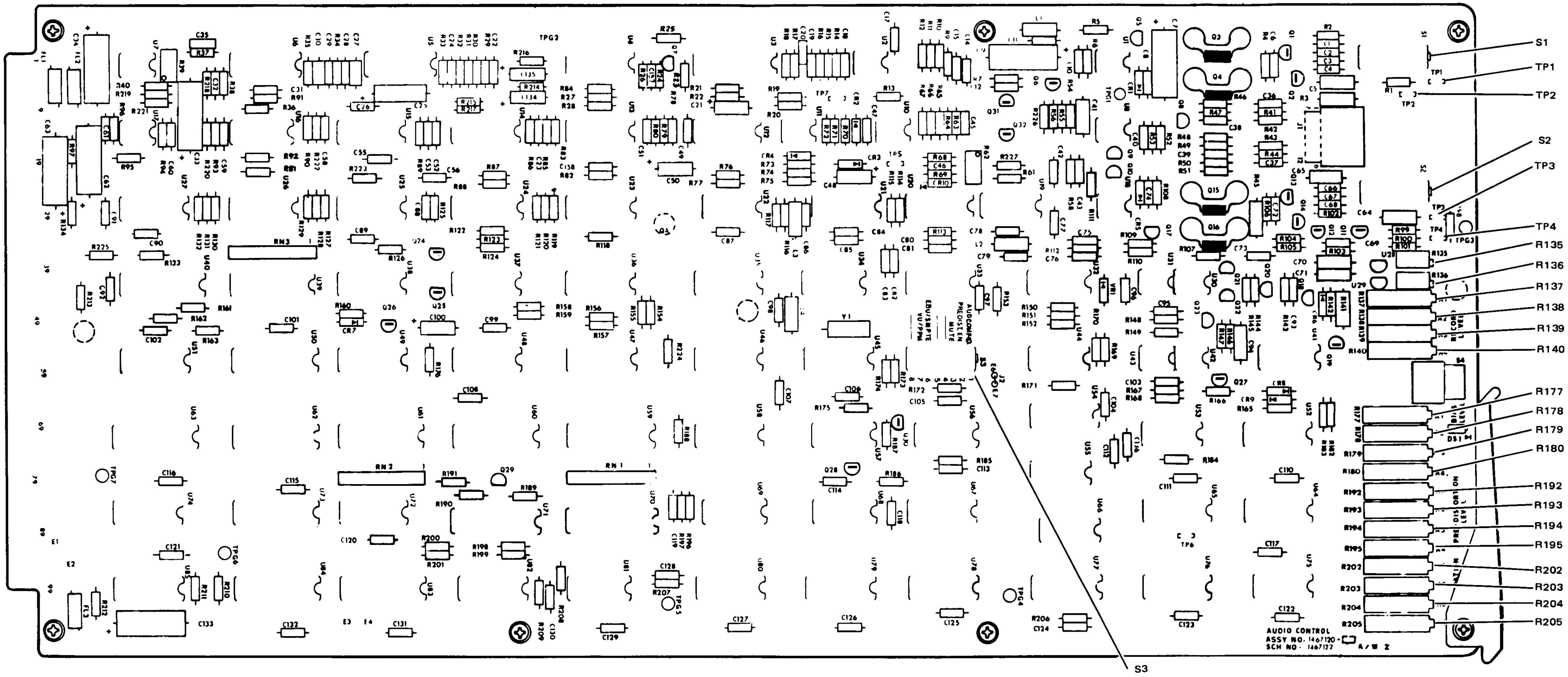


Figure 7-8.
Audio Control PWA Component
Location Diagram

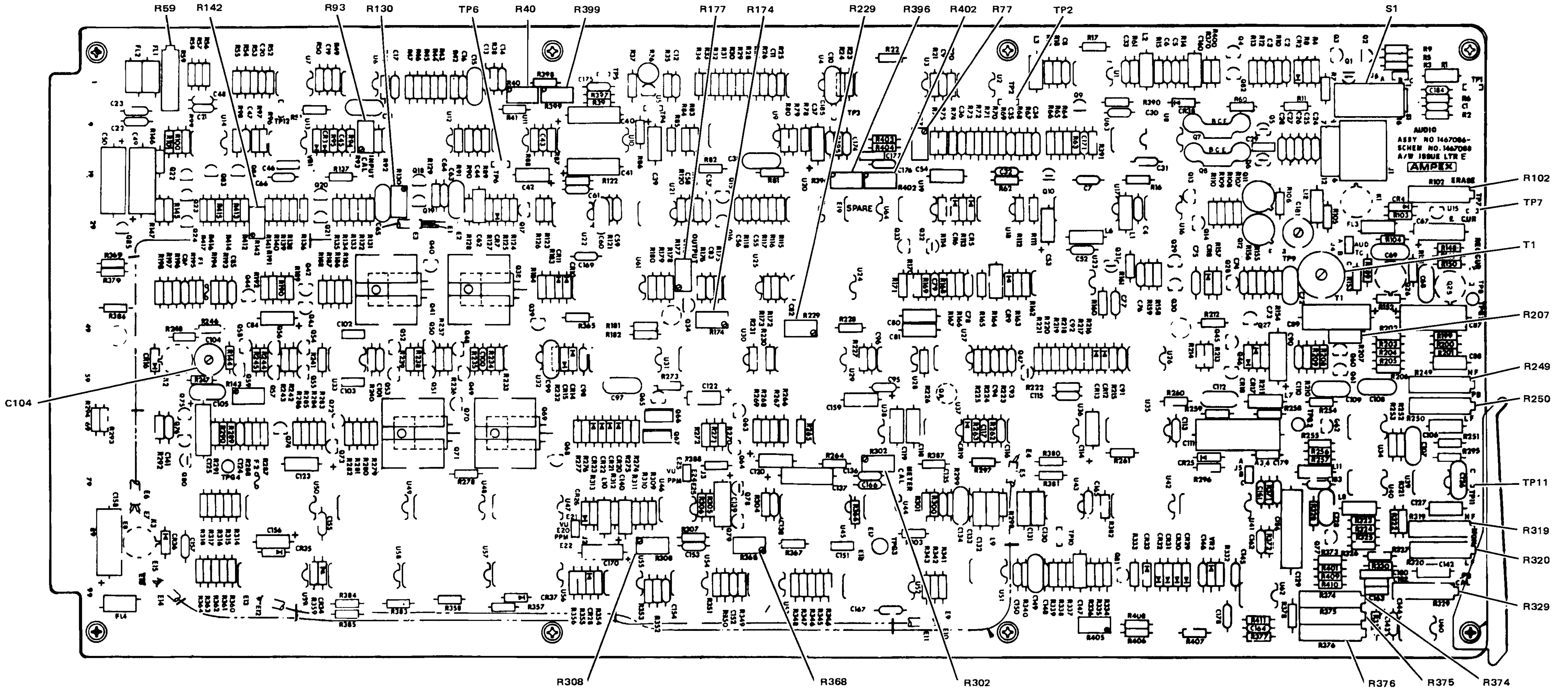


Figure 7-9.
Audio PWA Component
Location Diagram

of PWA 11 and for the two sine waves observed on the oscilloscope (149 kHz) to be in phase and at maximum amplitude. Ignore crossover distortion.

STEP 18 Press A3 soft key to take channel 3 out of record. Channel 4 should remain in record. Verify that signal at 11TP7 is at 4.5 Vp-p and there is no signal at 10 TP-7.

STEP 19 If necessary, adjust 11R102 (ERASE control on front of Audio 4 PWA) for 4.5 Vp-p at 11TP7.

STEP 20 Press A3 and A4 soft keys to take channel 4 out of record and place channel 3 into record. Verify that signal at 10TP7 is at 4.5 Vp-p and no signal occurs at 11TP7.

STEP 21 If necessary, adjust 10R102 (ERASE control on front of Audio 4 PWA) for 4.5 Vp-p at 10TP7.

STEP 22 Repeat steps 18 through 21, and verify that when both channels are in record that erase signals at 10TP7 and 11TP7 are both 4.5 Vp-p or greater, and when only one channel is in record that the erase signal for that channel does not go below 4.5 Vp-p.

7-39 E-E Adjustments

Correct adjustment of the E-E section of the audio system is important for proper system operation. If unity gain distribution level is not properly set, poor signal-to-noise or high distortion will cause a poor recording. These adjustments are done on the Audio PWAs, and are performed on each audio channel, one channel at a time. Adjustment locations on the Audio PWA are shown in Figure 7-9.

7-40 Input Calibration Adjustment

Input calibration adjustment is done via potentiometer R93 on the Audio PWA. Potentiometer R93 is adjusted so that a 1-kHz sine wave at unity gain distribution level (commonly +8 dBu but can vary from facility to facility) applied to the differential input with the system in UNITY produces a -3-dBu level at TP6 on the Audio PWA. Proceed as follows:

STEP 1 Connect an audio oscillator to the AUDIO 1 input connector on rear connector panel (or AUDIO 2, AUDIO 3, or AUDIO 4 as appropriate).

STEP 2 Set oscillator to 1 kHz at +8 dBu (or other desired system unity distribution level).

STEP 3 Set AUDIO 1 (or AUDIO 2, AUDIO 3, or AUDIO 4 as appropriate) REC and PB controls on operator control panel to unity (detent position) and set UNITY-VAR switch to UNITY.

CAUTION

TO PREVENT POSSIBLE HEAD MAGNETIZATION OR ELECTRICAL COMPONENT DAMAGE, TURN POWER OFF BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY.

STEP 4 Place Audio 1 PWA (or Audio 2, Audio 3, or Audio 4 as appropriate) on an extender. To remove an Audio PWA from its slot in the electronics bay, first remove audio head connector plug that mates with the PWA at the front of the board. Ensure that system power is turned off while removing or reconnecting PWAs. Note that all adjustments made while PWA is extended involve E-E signal levels; therefore, the heads need not be connected to the PWA while it is on the extender.

STEP 5 Monitor TP6 on the extended Audio PWA with an ac voltmeter and adjust R93 for a voltmeter reading of -3 dBu.

7-41 Output Calibration Adjustment

Output calibration is adjusted so the differential output signal level is equal to the facility's unity gain distribution level. Using unity gain distribution level, after input calibration (potentiometer R93) has been adjusted for -3 dBu at TP6, potentiometer R177 is adjusted so that differential output level is at desired unity gain distribution level. Proceed as follows:

Note

The VPR-3 audio system uses a transformerless differential output which acts as a transformer. If output is used to drive a single-ended load, one of the differential outputs should be grounded (one side of the load) and the other differential output will be the active drive (the other side of the load). When driving a differential input with the VPR-3, the output is true differential-centered around ground. With either a single-ended or a differential load, the signal level between the differential outputs is the same, allowing outputs to act as a transformer.

STEP 1 Assure that potentiometer R93 has been adjusted in accordance with procedure of paragraph 7-40, and that the VPR-3 and the test equipment are configured in accordance with steps 1 through 4 of paragraph 7-40.

STEP 2 Monitor AUDIO 1 output connector with an ac voltmeter and adjust R177 for house reference level (commonly +8 dBu).

7-42 Monitoring Calibration Adjustment

In this procedure, potentiometer R229, the monitoring calibration control, is adjusted so that a 1-kHz signal at the unity gain distribution level, applied to the VPR-3 while it is in UNITY and E-E, produces a level of -8 dBu at pin 28 of the Audio PWA. Proceed as follows:

STEP 1 Assure that potentiometers R93 and R177 have been adjusted in accordance with procedures of paragraphs 7-40 and 7-41, and that VPR-3 and test equipment are configured in accordance with steps 1 through 4 of paragraph 7-40.

STEP 2 Monitor pin 28 on extended Audio PWA with ac voltmeter and adjust R229 for a voltmeter reading of -8 dBu.

7-43 Calibration Adjustment

Meter calibration may have to be adjusted so that either a 0-vu deflection or 0-PPM (depending on what metering standard is being used) appears on control panel meters when a 1-kHz signal at the unity gain distribution level is applied to the VPR-3 while it is in UNITY and E-E. Proceed as follows:

STEP 1 Assure that potentiometers R93, R177, and R229 have been adjusted in accordance with procedures of paragraphs 7-40 through 7-42 and that VPR-3 and test equipment are configured in accordance with steps 1 through 4 of paragraph 7-40.

STEP 2 If necessary, adjust meter calibration potentiometer R302 for 0 vu (or 0 PPM) on control panel meter.

7-44 Peak Reading LED Adjustments

Peak reading LEDs on the control panel have a turn-on threshold that is user-adjustable. They are preset at the factory so that peaks of +8 dB above the unity record level (100 nWb/m) will light the LED, since the +8-dB point (251 nWb/m) is the typical 3% third harmonic distortion point for one-inch video tape recorded with no predistortion. If another threshold level is desired, adjustment is made by applying a signal with an amplitude equal to the required peak threshold level and adjusting potentiometer R308 only until the LED turns on. For example, the installation facility's unity gain distribution level is +8 dBu, and a peak threshold of +6 dB is required. A signal of +14 dBu is applied to the VPR-3 in UNITY and E-E, and potentiometer R308 is adjusted only to the point where the LED lights.

Although the threshold of these LEDs is adjustable over a very broad range, good recording practice dictates minimum and maximum threshold settings. If threshold is set at +6 dB, for instance, peaks registered by the LEDs would indicate distortion levels of 1% to 1.5% without predistortion, and well under 1% with predistortion. If threshold is set at +11 dB, peaks registered by the LEDs would indicate distortion levels of about 10% without predistortion, and 3% with predistortion. Since the purpose of these LEDs is to indicate signals peaking at the highest possible recording levels without excessive distortion for the best possible signal-to-noise ratio for the recording, limits of +6 dB to +11 dB for setting peak LEDs are practical. LEDs are in a peak-and-hold circuit, allowing visual indication of peaks which, if not held, would blink on and off too quickly to be seen.

7-45 2nd Harmonic Distortion

Minimize second harmonic distortion in the E-E channel as follows:

STEP 1 Assure that potentiometers R93 and R177 have been adjusted according to procedures of paragraphs 7-40 and 7-43, and that VPR-3 and test equipment are configured in accordance with steps 1 through 4 of paragraph 7-40.

STEP 2 Set oscillator input level to +8 dBu above facility's unity gain reference level.

STEP 3 Monitor second harmonic (2000 Hz) at TP6 on extended Audio PWA using wave or spectrum analyzer.

STEP 4 If necessary, adjust potentiometer R130 so that second harmonic component is greater than 60 dB below fundamental (1000 Hz).

STEP 5 If adjustment of R130 was necessary, repeat procedure of paragraph 7-41.

STEP 6 Set oscillator input level to facility's unity gain reference level (commonly 8 dBu).

STEP 7 Monitor second harmonic (2000 Hz) at TP3 using wave or spectrum analyzer.

STEP 8 Adjust potentiometer R40 for minimum second harmonic component (2000 Hz).

STEP 9 Set oscillator input level to +8 dBu above facility's unity gain reference level.

STEP 10 Monitor second harmonic (2000 Hz) at TP3 using wave or spectrum analyzer.

STEP 11 Adjust potentiometer R399 for minimum second harmonic component (2000 Hz) at TP3.

STEP 12 Repeat steps 6 through 11 for second harmonic to be at least 55 dB below input levels.

STEP 13 Use wave or spectrum analyzer and monitor signal at audio output connector on VPR's rear connector panel.

STEP 14 Switch UNITY-VAR switch to VAR and adjust AUDIO 1 REC control for output signal at audio output connector to be 8 dBu above unity gain distribution level.

STEP 15 If necessary, adjust potentiometer R174 so that second harmonic component is greater than 60 dB below fundamental (1000 Hz).

STEP 16 If adjustment of R174 was necessary, repeat procedure of paragraph 7-41.

7-46 Transformerless Output Circuitry Adjustment

Adjust potentiometer R143 and capacitor C104 as follows:

STEP 1 Set up VPR-3 and test equipment in accordance with steps 1 through 4 of paragraph 7-40.

STEP 2 Monitor PWA pins 31 and 33 with oscilloscope.

STEP 3 Adjust potentiometer R143 for equal amplitude signals at PWA pins 31 and 33.

STEP 4 Set oscillator to 10 kHz at unity distribution level.

STEP 5 Adjust capacitor C104 for equal amplitude signals at PWA pins 31 and 33.

7-47 Playback Adjustments

The audio playback signal path is designed to be stable, but as the heads wear, the system must be adjusted to compensate. The playback system should be checked periodically and readjusted if necessary. In addition, this procedure provides an overall system operation check. Use it to assess audio system operation. It should be used following a repair or PWA replacement.

7-48 Playback Level and High Frequency Playback Response Check and Alignment

This procedure is performed with the aid of an audio alignment tape. The tape is recorded with a series of tones, each tone persisting from 10 seconds to 1 minute (tones selected by ANSI Institute). The tape is introduced by voice announcement, and each tone is announced as well. A speaker or headphones must be used to identify tones. Track widths on the tape are much wider than those of normal VPR-3 recorded tracks. Excessive track width causes excessive signal from the guard band (called fringing data) to be picked up by the head(s). Increasing tone frequency decreases fringing so that, at 10 kHz, no fringing exists. The fringing data value is unique to each tape, and is included with each alignment tape.

CAUTION

DO NOT PROCEED IF ENTIRE TAPE PATH HAS NOT BEEN CLEANED AND DEGAUSSED. TO DO SO MAY DEGRADE PRECISION AUDIO ALIGNMENT TAPE.

STEP 1 Clean and degauss entire tape path.

STEP 2 Load appropriate SMPTE or EBU audio frequency response and play back level alignment tape onto VPR-3. Note fringing correction factors specified for this tape.

STEP 3 Turn off VPR-3 power, remove Audio Control PWA from electronics bay, set switch S3-5 on Audio Control PWA to OFF. Replace Audio Control PWA into electronics bay and turn on VPR-3 power.

STEP 4 Set AUDIO 1 (or AUDIO 2, AUDIO 3, or AUDIO 4 as appropriate) REC and PB controls on operator control panel to unity (detent position) and set UNITY-VAR switch to UNITY.

STEP 5 Ensure that Audio PWAs are plugged into card rack (not on an extender).

STEP 6 Connect an audio voltmeter to audio output connector corresponding to audio channel being aligned. This procedure is written to channel 1; align channels 2, 3, and (if applicable) 4 in the same manner.

STEP 7 Initiate playback of alignment tape and adjust P/B CAL control (R329) on the Audio PWA edge so the 1-kHz tone plays at house reference level plus fringing for the particular alignment tape.

STEP 8 Play back the 10-kHz tone on the alignment tape, and note that the 10-kHz tone on the alignment tape plays back at unity gain reference level. If it does not, adjust PLAY HF equalization control (R249) on Audio PWA front edge for unity gain reference level playback at 10 kHz.

STEP 9 Turn off VPR-3 power, remove Audio Control PWA from electronics bay, set switch S3-5 on Audio Control PWA to ON for setting monitor head electronics (this causes monitor head to play back audio from alignment tape). Replace Audio Control PWA into the electronics bay, and turn on VPR-3 power.

STEP 10 Initiate alignment tape playback, and adjust MON CAL control (R207) on the Audio PWA edge so the 1-kHz tone plays at the house reference level plus fringing for the particular alignment tape.

STEP 11 Note that the 10-kHz tone on the alignment tape plays back at unity gain reference level. If it does not, adjust MON HF equalization control (R319) on the front edge of the Audio PWA for unity gain reference level playback at 10 kHz.

STEP 12 Repeat procedure for the other audio channels.

7-49 Low-Frequency Check and Adjustment

STEP 1 Thread a reel of bulk-erased tape on the recorder.

STEP 2 Verify that a 1-kHz tone recorded at 0 vu plays back at 0 vu.

STEP 3 Set VPR to UNITY and TAPE, and record a tone of of 60 Hz at 0 vu while monitoring playback level from monitor head.

STEP 4 While monitoring playback, adjust LF MON potentiometer (R320, low-frequency equalization control) for a playback level of +1.0 vu.

STEP 5 Rewind this section of tape and play it back. While playing it back, adjust potentiometer R250 (playback low-frequency control) for a level of +1.0 vu.

7-50 Azimuth Check and Adjustment

The VPR-3 record/play head has an azimuth adjustment preset at the factory and should require no further adjustment. However, if the relative phase between the audio 1 channel and the audio 2 channel is large when playing back a high frequency audio signal from an Ampex audio alignment tape (or any other alignment tape which has been recorded using a head which covers both channels 1 and 2 on tape and has good azimuth), then the azimuth should be readjusted. To make the adjustment, monitor TP11 on both the Audio 1 PWA and the Audio 2 PWA, and adjust the head until signals are very close to peak playback signal amplitude, and in phase with each other while playing back a 16-kHz tone.

The head is moved by adjusting the two hex-recessed screws in the head mounting base. Screws are accessible through a hole in the head shield. The machine top trim piece must first be removed to gain access to the hole. The smaller screw is used as a set, and the larger screw is the adjustment. See Figure 7-10.

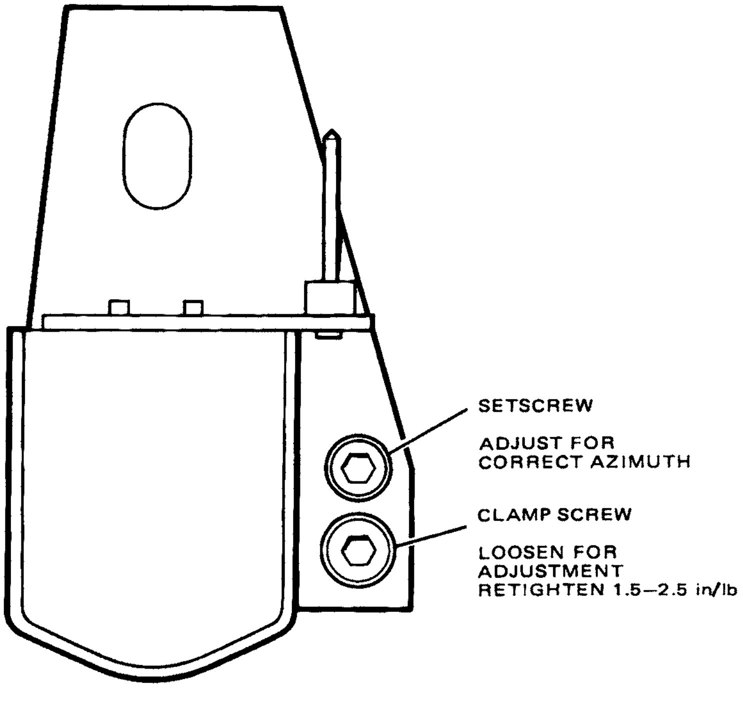

SETSCREW
ADJUST FOR CORRECT AZIMUTH
CLAMP SCREW
LOOSEN FOR ADJUSTMENT RETIGHTEN 1.5—2.5 in/lb

Figure 7-10. Record/Play Head Azimuth Adjustment

The playback section of the VPR-3 is divided into separate playback circuitry for both the record/play head and the confidence monitoring head, with full quality playback available from each. During setup of this circuitry, each head is adjusted independently. There is a switch on the Audio Control PWA (S3-5) which when ON allows the normal playback output signal to be from the monitoring head, and when OFF sends the record/play head signal to the output. During setup of the playback circuitry, complete the record/play head first (S3-5 OFF), and then proceed to optimize confidence monitoring head (S3-5, ON). Return switch S3-5 to OFF when setup is complete.

7-51 Record-Playback Alignment

7-52 Recorded Clicks and Pops Minimization. Minimize level of recorded clicks and pops as follows:

STEP 1 Turn power off.

STEP 2 Disconnect head from Audio 1 PWA at connector on front of Audio 1 PWA.

STEP 3 Place Audio 1 PWA on an extender and turn on power.

STEP 4 Thread a work tape on the VPR, and initiate record.

STEP 5 Connect oscilloscope to TP2.

STEP 6 Intermittently ground emitter of transistor Q33 and adjust potentiometer R77 for minimum excursions of signal at TP2.

STEP 7 Repeat procedure for the other audio channels.

STEP 8 Reconnect audio head stack.

7-53 Edit Cross-Talk Minimization

During edit recording when one audio channel is recording material and an adjacent channel is playing back, program material from the record channel can enter adjacent playback channel. Minimize edit cross talk between channels 1/2, 2/1, 3/4, and 4/3 as follows:

STEP 1 Thread a reel of bulk degaussed tape on the VPR-3.

STEP 2 Connect an audio oscillator to the AUDIO 1 IN connector on rear connector panel.

STEP 3 Set oscillator to 8 kHz at +6 dBu above reference level.

STEP 4 Use audio voltmeter to monitor audio signal output at AUDIO 2 OUT connector on rear connector panel.

STEP 5 From Home Menu, set editor to insert.

STEP 6 Enable record mode. From Enable Menu, insert recording can be initiated by pushing appropriate soft key, e.g., A1 Record.

STEP 7 Initiate insert edit record mode.

STEP 8 Adjust potentiometers R375 and R376 on Audio 1 PWA for minimum 8-kHz signal as measured on audio voltmeter.

STEP 9 Set oscillator to 100 Hz at +6 dBu above reference level.

STEP 10 With VPR-3 still in edit record mode, adjust potentiometer R374 on the Audio 1 PWA for minimum 100-Hz signal as measured on audio voltmeter.

STEP 11 Repeat steps 4 through 11.

STEP 12 Set oscillator to sweep from 100 Hz to 10 kHz at +6 dB above house reference level.

STEP 13 Monitor AUDIO 2 OUT, and observe that signal is greater than 30 dB below AUDIO 1 signal input.

STEP 14 Disconnect input signal from AUDIO 1 IN.

STEP 15 Monitor TP11 of Audio 2 PWA for bias cross talk of less than 3 Vp-p. Adjust capacitor C181 for minimal bias cross talk.

STEP 16 Monitor AUDIO 2 OUT. Make series of record on/record off transitions. Clicks and pops are due to bias ramping, and should be less than 1 Vp-p.

STEP 17 Repeat steps 1 through 17 to minimize cross talk between channels 2/1, 3/4, and 4/3.

7-54 Playback-Playback Cross-Talk Minimization

When two adjacent audio channels are playing back, program material from one channel can enter adjacent playback channel. Minimize playback cross talk between channels 1/2, 2/1, 3/4 and 4/3 as follows:

STEP 1 Thread a reel of bulk degaussed tape on the VPR-3.

STEP 2 Turn VPR power off; remove Audio 2 PWA from electronics bay, place on extender, replace extender in Audio 2 slot of electronics bay and turn power back on.

STEP 3 Turn editor off; inhibit recording on A2.

STEP 4 Connect audio oscillator to the AUDIO 1 IN connector on rear connector panel.

STEP 5 Set oscillator to 10 kHz at +6 dBu above reference level.

STEP 6 Make a one-minute recording of the 10-kHz signal on audio channel 1.

STEP 7 Rewind tape and playback signal recorded on channel 1.

STEP 8 Adjust potentiometer R405 on Audio 2 PWA for a minimum 10-kHz signal (more than 55 dB below reference).

STEP 9 Repeat steps 1 through 7 to minimize playback cross talk between channels 2/1, 3/4, and 4/3.

7-55 Record-Record Cross-Talk Minimization

When two adjacent audio channels are in record mode, signals being recorded on one channel can enter adjacent record channel. Minimize record cross talk between channels 1/2, 2/1, 3/4, and 4/3 as follows:

STEP 1 Thread a reel of bulk degaussed tape on the VPR-3.

STEP 2 Turn VPR power off; remove Audio 2 PWA from electronics bay, place on extender, replace extender in Audio 2 slot of electronics bay, and turn power back on.

STEP 3 Turn editor off; ensure that recording is not inhibited on audio channels 1 and 2.

STEP 4 Connect an audio oscillator to the AUDIO 1 IN connector on rear connector panel.

STEP 5 Set oscillator to 10 kHz at +6 dBu above reference level.

STEP 6 Make about a one-minute recording of the 10-kHz signal on audio channel 1. While recording, slowly turn potentiometer R402 on Audio 2 PWA from fully clockwise to fully counterclockwise; note the tape timer reading for each position of the potentiometer.

STEP 7 Rewind tape and play back audio channel 2. Any 10-kHz playback signal on channel 2 is a result of record cross talk from channel 1. Note tape timer reading at point where playback signal is minimum.

STEP 8 Set potentiometer R402 on Audio 2 PWA to position that resulted in minimum recorded signal on audio 2 track.

STEP 9 Repeat steps 1 through 7 to minimize playback cross talk between channels 2/1, 3/4, and 4/3.

7-56 Control Track Record/Audio 3 Record Cross-Talk Minimization (SMPTE)

In VPR-3s operating to SMPTE standards, control-track pulses are recorded on the control track with full saturation current. Cross talk between the control track record circuit and the audio 3 record circuits can cause control track pulses to be recorded on the audio 3 channel. Minimize this effect as follows:

STEP 1 Ensure that audio 3 channel is not inhibited, and editor is off.

STEP 2 Initiate record mode (no input signal supplied).

STEP 3 Connect oscilloscope to AUDIO 3 OUT connector (or observe on waveform monitor), and observe waveform. Observed waveform is being picked up from monitor head in the audio 3 channel, and is an image of the control track record current. It is a result of interhead pickup and intrahead pickup. See Figure 7-11.

STEP 4 Adjust potentiometer R396 on Audio 3 PWA to minimize the portion of the monitored waveform indicated in Figure 7-11.

STEP 5 Rewind tape. Then play back and check that waveform on audio 3 channel is less than 25 mVp-p.

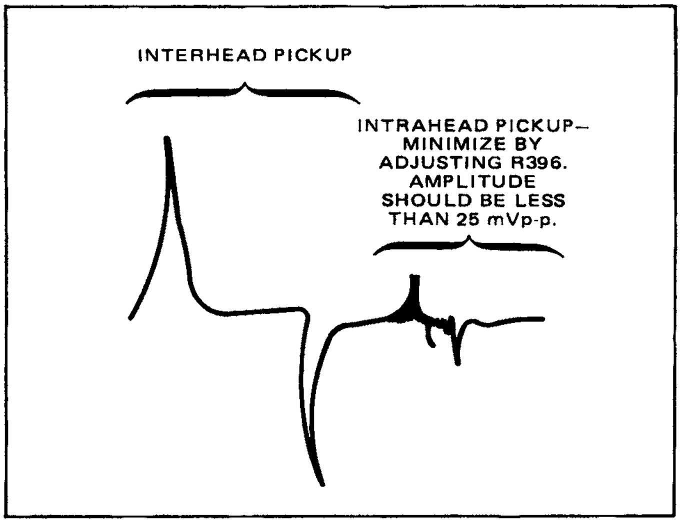


Figure 7-11. Control Track/Audio 3 Cross Talk

7-57 Storing Record Optimization Setup Data for Three Commonly Used Tape Types

VPR-3 record parameters can be adjusted in any of three ways:

- Automatically, using machine control microprocessor.
- Manually, using tape speed control knob as the adjustment.
- Manually, using potentiometers located on the edge of the Audio Control PWA.

Two distinct automatic record optimization setup processes are possible with the VPR-3. The first is automatic optimization accompanied by data storage. The second process is automatic optimized setup from stored data; this procedure is used more frequently. In addition, record parameters can be adjusted manually using potentiometers located on the Audio Control PWA edge.

The VPR-3 can automatically optimize record parameters for its audio, video, and sync channels, and store data representing values for optimized parameters in its memory for later recall. In the case of the audio channels, record parameters that can be optimized are bias, record current level, high-frequency equalization, and third harmonic predistortion. Video and sync channels are optimized in record current level only.

Optimum record parameters differ with different tape types. Up to three sets of record parameter setup data, corresponding to three tape types, can be stored. In typical use, a set of data will be stored for each of the three most frequently used tape types. Then, prior to a recording session, after a tape is threaded on the VPR, the operator identifies that tape type to the VPR. The VPR then recalls the appropriate record parameter setup data from memory and uses the data to automatically set record circuitry to produce an optimum recording.

7-58 Automatic Optimization

The procedure given here is the procedure for generating and storing data representing values for optimized record parameters for three tape types. Proceed as follows:

STEP 1 Determine which are the three most commonly used tape types at the VPR-3 installation site.

Note

The VPR-3 has been tested and adjusted using Ampex 196 high-energy video tape. Ampex recommends use of this tape for optimum recording and playback performance.

STEP 2 Designate one reel of each of three tape types as TAPE 1, TAPE 2, and TAPE 3.

Note

It is very important that each operator know at all times the type of tape currently designated TAPE 1, TAPE 2, OR TAPE 3.

STEP 3 Make a written record of these designations and post it prominently so that all operating personnel are informed. Update this record when any changes are made.

STEP 4 Thread a reel of bulk degaussed tape of the tape type that has been designated TAPE 1 on the VPR.

STEP 5 Display Tape Setup menu on fluorescent display.

STEP 6 Press TAPE 1 soft key; TAPE 1 is displayed on fluorescent display panel in tape type field.

STEP 7 Press SETUP; Automatic Optimization menu is displayed and TAPE 1 remains in the tape type display field on fluorescent display panel.

STEP 8 Put VPR into record mode. Ensure that none of the channels is inhibited.

CAUTION

PUSHING THE autoA OR autoV SOFT KEY CAUSES ONLY PARTIAL RECORD OPTIMIZATION DATA TO BE STORED. AT ANY TIME DURING AUTOMATIC SETUP, PRESSING THE end SOFT KEY WILL STOP THE SYSTEM WHERE IT IS IN THE SETUP, THE SYSTEM WILL REMEMBER ONLY THE NUMBERS ENTERED INTO MEMORY BEFORE end WAS PUSHED. THIS ALLOWS THE SETUP TO BE COMPLETE OR ONLY PARTIAL. IF ONLY AUDIO REQUIRES SETUP, autoA IS USED TO SET UP ONLY AUDIO FUNCTIONS, AND autoV IS USED TO SET UP ONLY THE VIDEO SYSTEM.

STEP 9 Press **auto** soft key. This initiates automatic optimization of audio and video channels. When machine is in record mode and **auto** is pushed, the VPR automatically sets up record parameters for selected tape type for both the audio and video system. As the machine performs the setup, each function is displayed on the display panel as it is being done. A bar graph indicates signal level being read back from off tape by built-in test equipment. When optimization process is complete, optimized parameter values for the tape type (TAPE 1) indicated in the display field are stored in memory.

STEP 10 Perform steps 4 through 9 for TAPE 2 and TAPE 3.

7-59 Manual Audio Channel Record Setup

To manually adjust audio channel record parameters, press **prset** on Tape Setup menu. This instantly transfers control of the audio channel record/playback parameters to the 16 potentiometers on the edge of the Audio Control PWA 12 in the electronics bay; video record level will also be under control of the VIDEO RECORD DRIVE potentiometer on the front of the Modulator PWA if the OPTIMIZE switch (also on the Modulator PWA) is set to MAN. Next, press **setup** to bring up the Preset Setup menu and activate built-in record optimization circuitry. Put VPR-3 in record mode to enable bar graph and cursor on menu display.

Potentiometer controls on the Audio Control PWA are in four groups; each group has four adjustments. From the top down, the groups are record level, bias level, predistortion level, and high-frequency equalization. Within each group, from top to bottom, adjustments are for audio channel one through audio channel four.

Using the Preset Setup menu, the operator steps through the record parameters (by pressing **afunc**), and audio channels (by pushing **achan**); the fluorescent display indicates the parameter and the channel being adjusted. Adjustment for each parameter is done with the aid of the bar graph in the center of the control panel display, the same as the adjustment done with the Knob Controlled Record Optimization menu.

When this menu is selected, test equipment built into the VPR-3 is operating. Test tones are generated, recorded on tape, and played back. The VPR must be put in the record mode (REC LOCKOUT ON/OFF toggle switch on PWA 20 set to OFF, no record inhibits set via the Audio/Video Channel Enable menu), and the OPTIMIZE AUTO/MAN toggle switch on the Modulator PWA 1 in the electronics bay set to MAN.

Length of the bar graph represents the off-tape signal level. For each parameter selected (except predistortion), a cursor (a mark located at a point along the bar graph's length) indicates the correct playback level that should be obtained for optimum performance.

The order in which audio setup parameters are adjusted is:

1. Bias level
2. Record level
3. High-frequency equalization
4. Predistortion

Bias level is adjusted while an internally generated 10-kHz tone is recorded and played back. The bias level setting is correct if recording is overbiased by 2 dB. For this setting, bias level is increased until off-tape signal peaks, then increased further until signal level drops by 2 dB from peak amplitude. This is the optimum point in the trade-off between distortion and high-frequency sensitivity, using tape the thickness of current 1-inch video tape. The cursor marks the correct setting.

Record level is adjusted for unity gain on and off tape. During this adjustment, an internally generated 1-kHz tone is recorded and played back. Record current level is adjusted for a playback level of 0 vu, with playback gain set to unity. The cursor marks the correct setting.

High-frequency equalization adjustment is made during automatic record and playback of an internally generated 10-kHz tone. The tone is recorded at a level of 0 vu. Equalization is adjusted to give a +0.5-dB boost from off-tape; this gives optimum high-frequency performance through 20 kHz. The cursor marks the correct setting.

The third harmonic predistortion record component is adjusted while the internal 1-kHz sine wave oscillator is recording a signal amplitude of +8 vu. The bar graph displays the amount of third harmonic distortion in the playback signal, and correct adjustment is made when the bar graph length is minimum. Note that, as a matter of policy, some facilities elect not to use predistortion. Ensure that DIP switch

S3-2 (PREDISTORTION ON/OFF) on the Audio Control PWA 12 has been set to ON before attempting to optimize predistortion.

Finally, record level should be rechecked using a 1-kHz signal at 0 vu because a readjustment in predistortion level could change record level slightly (± 0.3 dB).

Thread a reel of bulk degaussed tape on the VPR. Tape must be the type for which potentiometers on the front of the Audio Control PWA are used to store record/playback parameters. Adjust bias, record level, high-frequency equalization and pre-distortion according to procedures given in paragraphs 7-60 through 7-63.

7-60 Manual Bias Setup

Set record bias amplitude in audio channels via potentiometers on front of Audio Control PWA as follows:

Note

> **Audio PWAs must not be on an extender when making these adjustments.**

STEP 1 Enter Preset Setup menu (from Home menu press **setup, tape, preset,** then **setup** soft keys).

STEP 2 Place VPR in record mode.

STEP 3 Press **achan** soft key to select audio channel 1.

STEP 4 Press **afunc** soft key to select bias adjustment mode.

STEP 5 Adjust potentiometer R177 on Audio Control PWA 12 (topmost control in group of four potentiometer controls of the BIAS LEVEL group, see Figure 7-8. First turn control fully counterclockwise, and then slowly turn control clockwise while watching bar graph on the fluorescent display on control panel. Set control for bar graph to line up on the cursor. A slight delay occurs between record head and monitor head, so this adjustment must be made slowly. As potentiometer R177 is adjusted clockwise, the vu meter reading will increase to some level and then start to decrease. Vu meter reading should decrease 2 vu from maximum when bias is properly set.

STEP 6 Press **achan** soft key to select audio channel 2.

STEP 7 Using procedure given in step 5, adjust potentiometer R178 to adjust bias in audio channel 2.

STEP 8 Repeat steps 6 and 7 for audio channel 3 and, if installed, channel 4. Potentiometer R179 controls bias in channel 3; potentiometer R180 controls bias in channel 4.

7-61 Manual Record Level Setup

Set record levels in audio channels via potentiometers on front of Audio Control PWA as follows:

Note

Audio PWAs must not be on an extender when making these adjustments.

STEP 1 Enter Preset Setup menu (from Home menu press **setup, tape, preset,** then **setup** soft keys).

STEP 2 Place VPR in record mode.

STEP 3 Press **achan** soft key to select audio channel 1.

STEP 4 Press **afunc** soft key to select record level (rclev) adjustment mode.

STEP 5 Adjust potentiometer R137 on Audio Control PWA 12 (topmost control in group of four potentiometer controls of the REC LEV group, see Figure 7-8.) First turn control fully counterclockwise then slowly turn control clockwise while watching bar graph on fluorescent display on control panel. Set control for bar graph to line up on cursor. Vu meter should indicate approximately 0 vu.

STEP 6 Press **achan** soft key to select audio channel 2.

STEP 7 Using procedure given in step 5, adjust potentiometer R138 to adjust record level in audio channel 2.

STEP 8 Repeat STEPS 6 and 7 for audio channel 3 and, if installed, channel 4. Potentiometer R139 controls record level in channel 3; potentiometer R140 controls record level in channel 4.

7-62 Manual Record High-Frequency Equalization

Set high-frequency equalization in audio channels via potentiometers on front of Audio Control PWA as follows:

Note

Audio PWAs must not be on an extender when making these adjustments.

STEP 1 Enter Preset Setup menu (from Home menu press **setup, tape, preset,** then **setup** soft keys).

STEP 2 Place VPR in record mode.

STEP 3 Press **achan** soft key to select audio channel 1.

STEP 4 Press **afunc** soft key to select equalization (equal) adjustment mode.

STEP 5 Adjust potentiometer R202 on Audio Control PWA 12 (topmost control in group of four potentiometer controls of the EQ group, see Figure 7-8. Slowly turn control while watching bar graph on fluorescent display on control panel. Set control for bar graph to line up on cursor. Vu meter should indicate approximately +0.5 vu.

STEP 6 Press **achan** soft key to select audio channel 2.

STEP 7 Using procedure given in step 5, adjust potentiometer R203 to adjust equalization in audio channel 2.

STEP 8 Repeat steps 6 and 7 for audio channel 3 and, if installed, channel 4. Potentiometer R204 controls equalization in channel 3; potentiometer R204 controls equalization in channel 4.

7-63 Manual Record Predistortion Adjustment

Set record predistortion in audio channels via potentiometers on front of Audio Control PWA as follows:

Note

Audio PWAs must not be on an extender when making these adjustments.

STEP 1 Enter Preset Setup menu (from Home menu press **setup, tape, preset,** then **setup** soft keys).

STEP 2 Place VPR in record mode.

STEP 3 Press **achan** soft key to select audio channel 1.

STEP 4 Press **afunc** soft key to select predistortion (predis) adjustment mode.

STEP 5 Adjust potentiometer R192 on Audio Control PWA 12 (topmost control in group of four potentiometer controls of the PRE DIST group, see Figure 7-8). Slowly turn control while watching bar graph on fluorescent display on control panel. Set control for minimum length of bar graph.

STEP 6 Press **achan** soft key to select audio channel 2.

STEP 7 Using procedure given in step 5, adjust potentiometer R193 to adjust predistortion level in audio channel 2.

STEP 8 Repeat steps 6 and 7 for audio channel 3 and, if installed, channel 4. Potentiometer R194 controls predistortion in channel 3; potentiometer R195 controls predistortion in channel 4.

STEP 9 Repeat record level adjustment procedure of paragraph 7-61.

STEP 10 Press end soft key and return to Home menu.

7-64 Knob-Controlled Record Optimization and Data Storage

Record parameters can be adjusted from the Knob Controlled Record Optimization menu. From this menu, any record parameter can be recalled from VPR memory, and adjusted using the tape speed control knob. The new value can be stored in memory.

The fluorescent display indicates parameter and channel being adjusted. The **achan** and **afunc** soft keys step through the audio channels and audio functions, respectively; **video** and **sync** soft keys select video and sync channels. Parameter selected and named in the display is controlled by the tape speed control knob.

When video or sync record current is being adjusted, the tape speed control knob operates as a one-turn potentiometer; when an audio channel record parameter is being adjusted, the knob operates as an eight-turn potentiometer.

When this menu is selected, test equipment built into the VPR is operating. Test tones are generated, recorded on tape, and played back. The VPR must be put in record mode: REC LOCKOUT ON/OFF on PWA 20 OFF, no record inhibits set via the Audio/Video Channel Enable menu, and the OPTIMIZE AUTO/MAN on the Modulator PWA 1 set to AUTO.

A bar graph and a cursor appear on the fluorescent display. Length of the bar graph represents level of the off-tape signal. For each parameter selected (except predistortion), a cursor (a mark located at a point along the bar graph's length) indicates correct playback level that should be obtained for optimum performance. Each parameter that has been adjusted must be entered by pressing **enter** after correct parameter value has been set. If any other soft key is pushed first, parameter being adjusted will remain at the previously stored number.

The order in which audio setup parameters are adjusted is bias level first, record level second, high-frequency equalization third, and predistortion last.

Bias level is adjusted while an internally generated 10-kHz tone is recorded and played back. The bias level setting is correct if recording is overbiased by 2 dB. For this setting, bias level is increased until off-tape signal peaks, then bias is increased further until signal level drops by 2 dB from peak amplitude. This is the optimum point in the trade-off between distortion and high-frequency sensitivity using tape with the thickness of current 1-in. video tape. The cursor marks the correct setting.

Record level is adjusted for unity gain on and off tape. During this adjustment, an internally generated 1-kHz tone is recorded and played back. Record current level is adjusted for a playback level of 0 vu, with playback gain set to unity. The cursor marks the correct setting.

High-frequency equalization adjustment is made during automatic record and playback of an internally generated 10-kHz tone. The tone is recorded at a level of 0 vu. Equalization is adjusted to give a +0.5-dB boost from off-tape; this gives optimum high-frequency performance through 20 kHz. The cursor marks the correct setting.

The third harmonic predistortion record component is adjusted while the internal 1-kHz sine wave oscillator is recording a signal amplitude of +8 vu. The bar graph displays the amount of third harmonic distortion in the playback signal, and correct adjustment is made when the bar graph length is minimum. Note that, as a matter of policy, some facilities elect not to use predistortion. Ensure that DIP switch S3-2 (PREDISTORTION ON/OFF) on the Audio Control PWA 12 is ON before attempting to optimize predistortion.

Next, record levels in video and sync channels are optimally set and correct values stored.

After each parameter value is correctly set, it must be entered in memory by pressing **enter.** If any other soft key is pushed first, the adjusted parameter will not be stored in memory, and memory contents for the parameter will remain at the previously stored number.

Make a written record of which tape types are called TAPE 1, TAPE 2, and TAPE 3. Post this record prominently so that all operating personnel are informed. Update the record when any changes are made; in addition to noting any changes of tape types, note any changes to stored data that may have been made.

SECTION 8
POWER SUPPLY SYSTEM

8-1 INTRODUCTION

This section describes VPR-3 power supply functional operation, and provides adjustment procedures and block diagrams. Locations of major elements of the power supply are illustrated. Schematic diagrams of circuits described herein can be found in the VPR-3 Parts Lists and Schematics manual, Catalog No. 18096088.

8-2 POWER SUPPLY SYSTEM OVERALL THEORY OF OPERATION

A block diagram of the VPR-3 power system is shown in Figure 8-1. Power supply circuitry is contained on the Power Supply Motherboard PWA, the Regulator PWA, and the 24 Volt Regulator/AST Driver PWA.

The power supply can use primary power from 95 to 270 Vac. Power transformer primary windings are connected in parallel for 95V to 135V operation, and in series for 190V to 270V operation. Two jumper plugs are used for selecting appropriate input voltage windings within ranges of 95 to 135 Vac or 190 to 270 Vac. Instructions for installation of line voltage selector plugs are placarded on the power supply chassis back panel; instructions are visible when power supply chassis is lowered out of the VPR-3 frame on its air hinges. Main power is turned on and off via the main power circuit breaker linked to the ON-OFF switch at the front of the VPR. An auxiliary coil on the circuit breaker triggers the breaker automatically when an overvoltage condition is sensed. An overvoltage circuit monitors voltage at drive terminals of scanner, supply, and takeup motors. If this voltage exceeds 95V, the monitor circuit produces a signal that trips the main circuit breaker.

Main power transformer secondary windings are tapped at 300V, 24V, and 77V. Fuse-protected 300V center-tapped windings feed a bridge rectifier followed by dual 250V linear regulators that produce the +,- 250 Vdc required by AST drivers.

Circuit-breaker-protected, center-tapped, 24V windings followed by diode bridges, filters, and regulators provide the +,- 24 Vdc supply as well as the +12 Vdc lamp supply.

The 77V secondary tap on the main power transformer feeds a full-wave rectifier whose output powers reel, scanner, and capstan MDAs, and also a dc-to-dc converter that produces +5 Vdc, and +,- 12 Vdc. The bridge circuit's full-wave rectified output is chopped at 50 kHz, and used as input to the primary of high-frequency transformer T1. Filters and regulators on the secondary side of T1 produce the +/-12 Vdc and +5 Vdc. Remote sensing circuits monitor voltages and feed them back to the regulators. Crowbar and overcurrent protection is provided.

Overvoltages sensed at the output of the crowbar-protected circuits ground the output through an SCR that is turned on and latched. Overcurrent foldback circuits limit maximum current that the supplies provide.

Logic circuits monitor the power supply for fault conditions, and can switch off power to the MDAs if necessary. A block diagram of this power fail logic system is shown in Figures 8-2.

8-3 Regulator PWA, A1 P/S, Assembly No. 1467310

The Regulator PWA is located in slot 1 of the power supply bay. It supplies regulated +5 Vdc, +,-12 Vdc. It also produces filtered +83 Vdc and +57 Vdc. Bridge-rectified +70 Vdc enters the PWA at pins 1 through 10, and drives the primary winding of transformer T1 through FETs Q8 and Q9. Gate circuits are fuse-protected via fuses F1 and F2. FETs Q8 and Q9 are alternately gated to conduction and nonconduction at a 50-Khz rate by oscillator U1 operating through switching logic U2,U3,U7 and driver transistors Q1-Q4. This alternates the flux through the coil of step-down transformer T1.

Circuitry on the primary side of T1 provides preregulation. Feedback sense circuit U5,Q5 monitors the +13 produced in the secondary side of the transformer, and causes the switching logic circuit U2, U3, U7 to buck voltage changes by adjusting the duty cycle of transistors Q8, Q9. Possible asymmetry of current pulses generated by transistors Q8,Q9 could cause an undesirable dc current component in the transformer's primary winding. The dc component is nulled by ramp generator U5, current sensing resistor R40, and comparator U6, which constrain the switching logic to operate transistors Q8 and Q9 symmetrically. When main power is turned on, startup limit circuit U4 eliminates current surges by controlling the switching logic circuit. Initially it holds the duty cycle to zero, and then slowly increases it until full voltage is reached.

Stepped-down ac voltage at the transformer's secondary windings is bridge-rectified, filtered, and regulated to produce the +5 Vdc, +, -12 Vdc power in three voltage regulation channels. The channel that produces the +12V power will be discussed here; the other channels operate similarly. The secondary of transformer T1 is connected to diode bridge CR13, whose full-wave rectified output is smoothed by ripple filters L6, L8, C35, C52 before being applied to pass transistor Q15. Regulator control circuit U14, U16, Q16 controls voltage across pass transistor Q15 by adjusting emitter-base current in response to changes in the remotely sensed +12V. The regulator control circuit also sharply reduces output voltage during overcurrent conditions when excessive current is sensed through resistor R100 by overcurrent foldback circuit U15.

8-4 24 Volt Regulator/AST Driver PWA, A2 P/S, Assembly No. 1467320

The 24 Volt Regulator/AST Driver PWA is located in power supply bay slot 2. It produces filtered +, -24 Vdc used by the Audio PWAs, +24 Vdc used by the air compressor relay, and +12 Vdc used by the control panel lamps and AST drive voltages. In addition, this PWA contains power supply voltage output monitoring logic that issues a power fail signal if any of the monitored voltages drop below 5V.

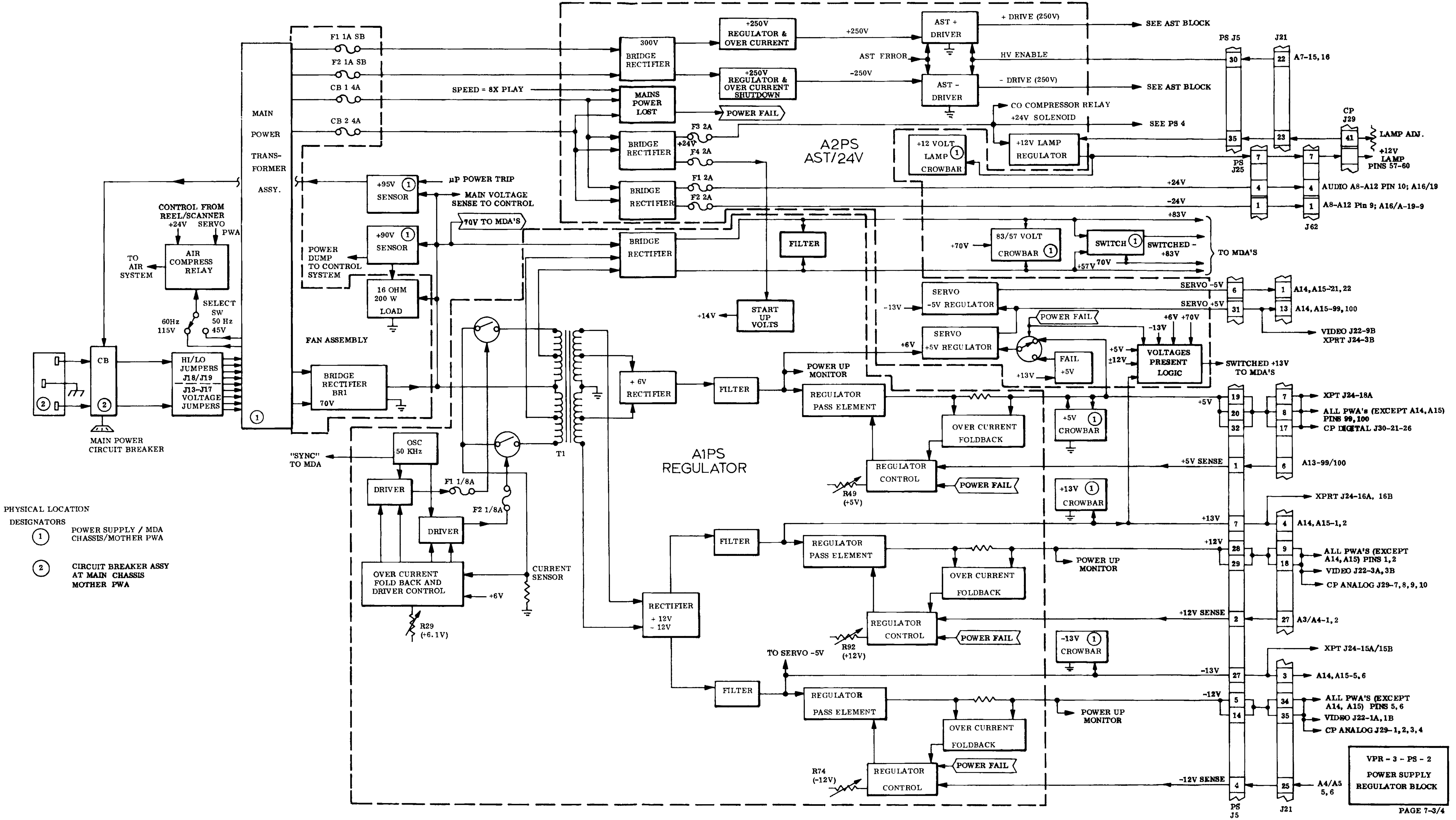


Figure 8-1.
Power Supply Block Diagram
(Sheet 1 of 3)

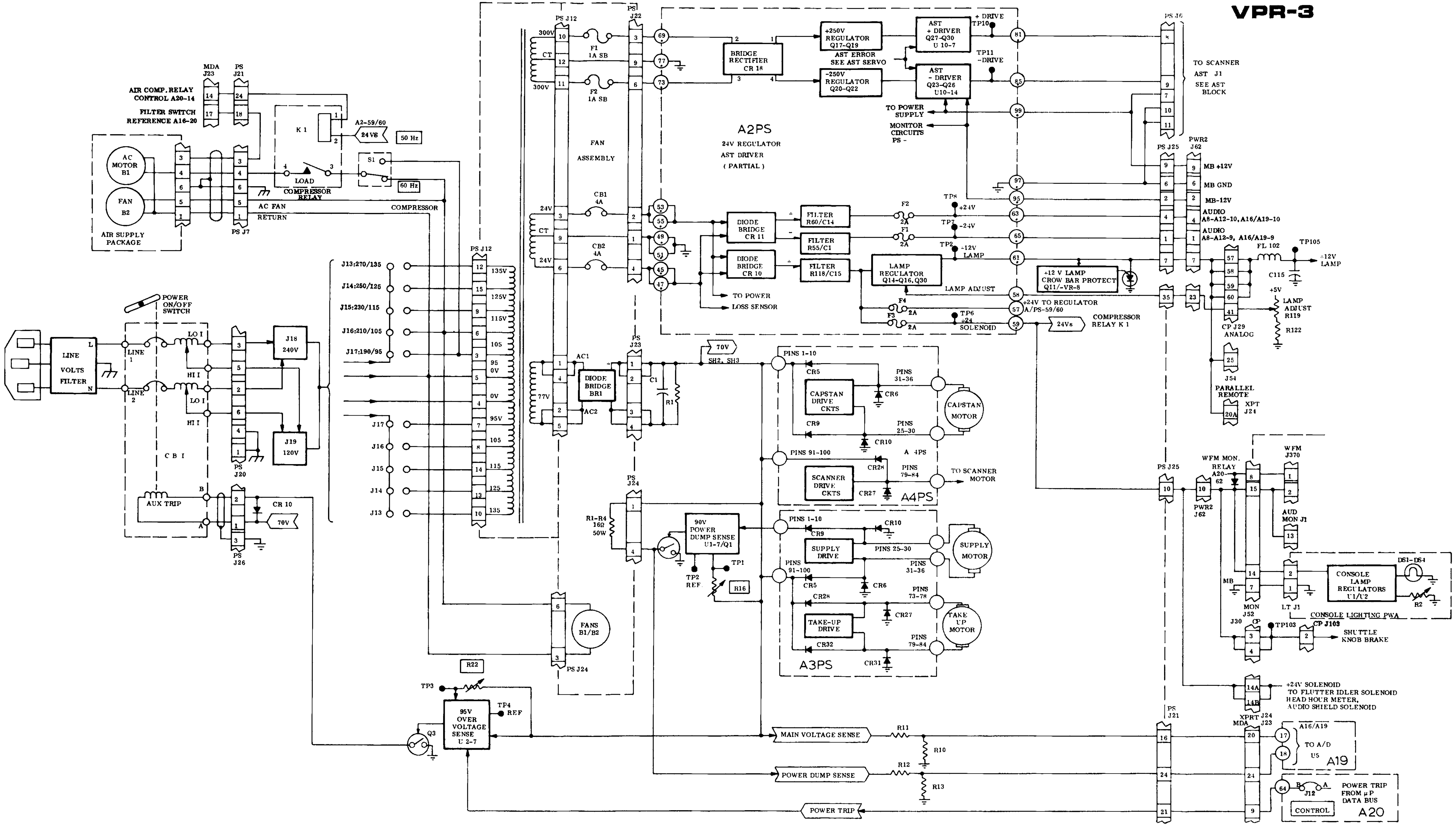


Figure 8-1.
Power Supply Block Diagram
(Sheet 2 of 3)

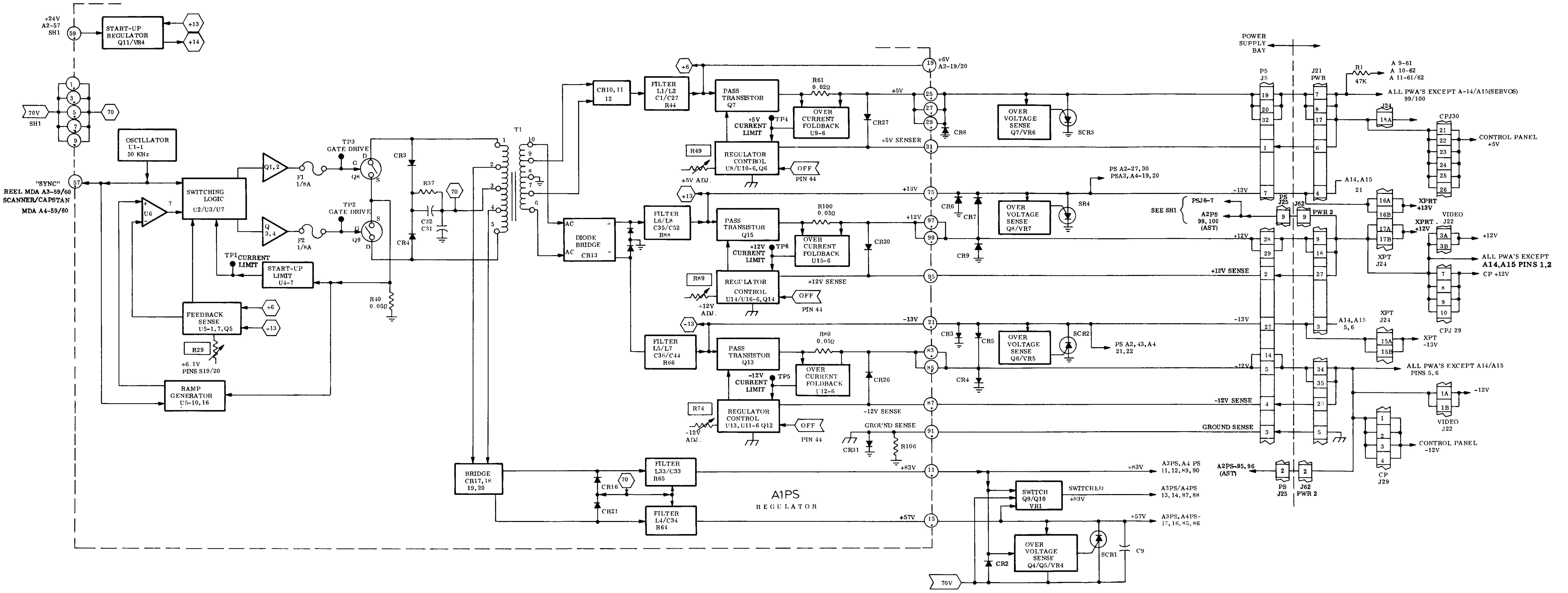
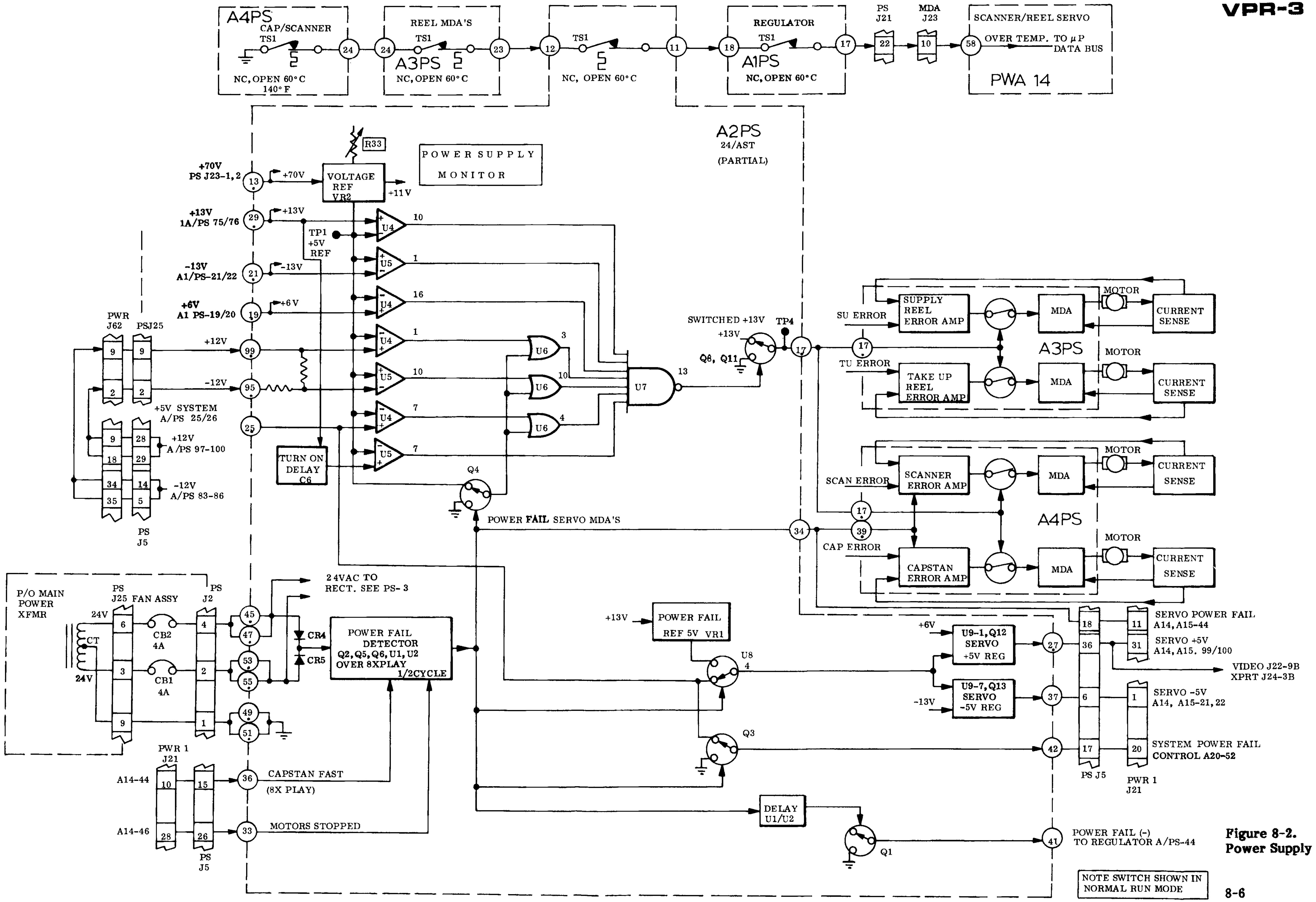


Figure 8-1.
Power Supply Block Diagram
(Sheet 3 of 3)



NOTE SWITCH SHOWN IN NORMAL RUN MODE

Figure 8-2.
Power Supply Power Fail System

The +, -250V drive voltages supplied to the AST head are generated in the AST + drive Q27-Q30 and AST - drive Q23-Q26 circuits. Nominal 250V drive voltage is increased or decreased in response to the AST error signal produced by the AST Servo PWA. The +250V regulator Q17-Q19 and -250V regulator Q20-Q22 circuits produce regulated power from the full-wave rectified power provided by bridge rectifier CR18, which is connected to a center-tapped coil on the main power transformer's secondary side.

Diode bridge CR11 feeds filters R60, C14 and R55,C1, which produce +24 Vdc and -24 Vdc, respectively. Regulated +12V lamp power is produced by circuitry consisting of lamp regulator Q14, Q16, Q30, filter R18, C15, and diode bridge CR10.

8-5 LOCATION OF POWER SUPPLY SYSTEM COMPONENTS

Power supply location is shown in Figures 8-3 and 8-4.

8-6 POWER SUPPLY SYSTEM ALIGNMENT PROCEDURES

WARNING

ALL PWAS IN THE POWER SUPPLY CHASSIS HAVE POTENTIALLY LETHAL VOLTAGES PRESENT. TO AVOID INJURY, TAKE ADEQUATE PRECAUTIONS WHEN WORKING IN THESE AREAS.

Power supply alignment is not a routine procedure. Power dump and circuit breaker trip adjustment should be done only if there are problems. Low-voltage supplies can be checked from the front of the machine, and should not be adjusted if within 10 mV of specified voltage.

CAUTION

ALL PWAS IN THE POWER SUPPLY CHASSIS CONTAIN STATIC-SUSCEPTIBLE COMPONENTS. OBSERVE PRECAUTIONS FOR HANDLING STATIC-SUSCEPTIBLE COMPONENTS WHEN ALIGNING POWER SUPPLY.

8-7 Line Voltage Select Jumpers

Two-line voltage selector plugs on the Power Supply Motherboard PWA (see Figure 8-5) are set to accommodate power supply to the particular line voltage of power delivered to the site. With jumpers properly set, the VPR-3 can use power ranging from 95 Vac to 270 Vac. These jumpers should be checked for correct placement when the VPR-3 is relocated or line voltage has changed. Measure line voltage, and set jumpers according to data given in Table 8-1.

CAUTION

ALWAYS TURN VPR POWER OFF BEFORE REMOVING OR INSTALLING PRINTED WIRING ASSEMBLIES (PWAs). WAIT A MINIMUM OF 30 SECONDS AFTER TURNING OFF POWER BEFORE REMOVING OR REPLACING A PWA IN THE POWER SUPPLY ASSEMBLY.

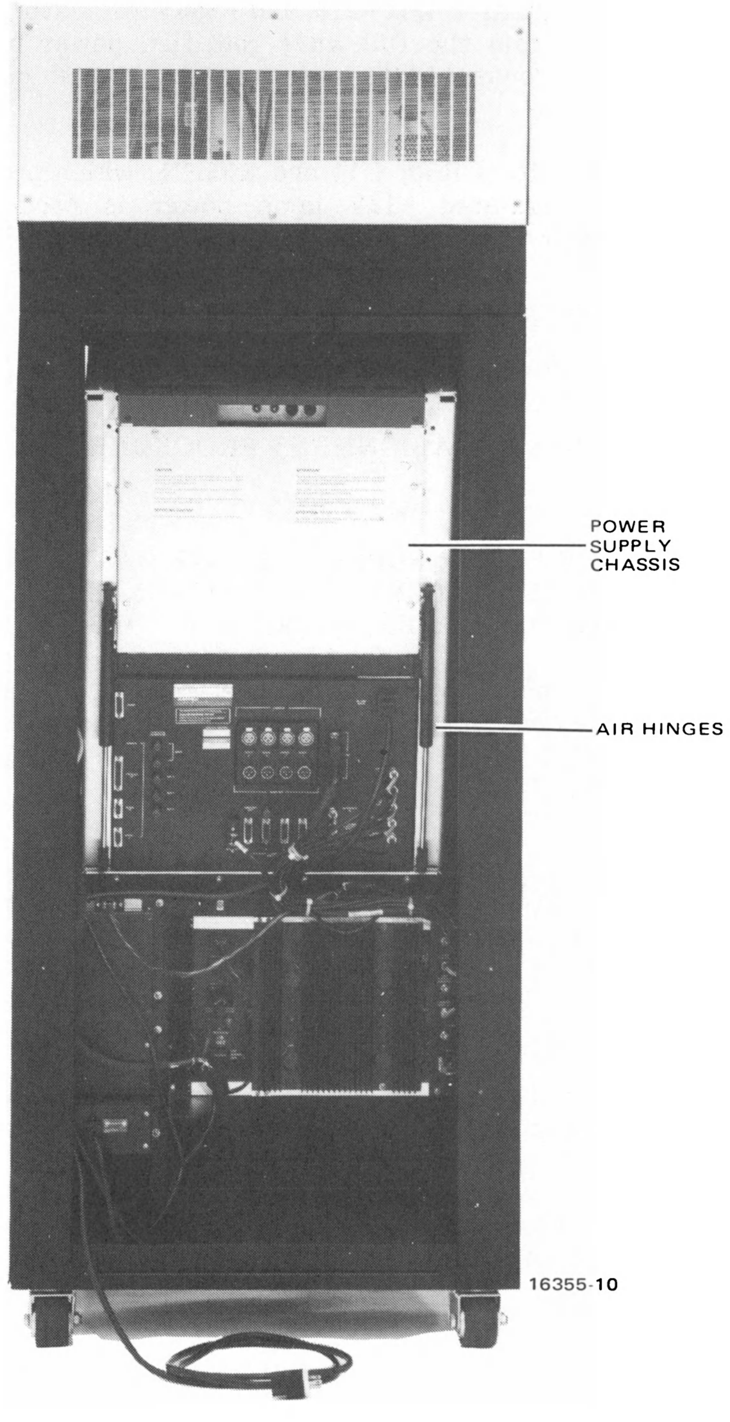


Figure 8-3. Power Supply Chassis Location

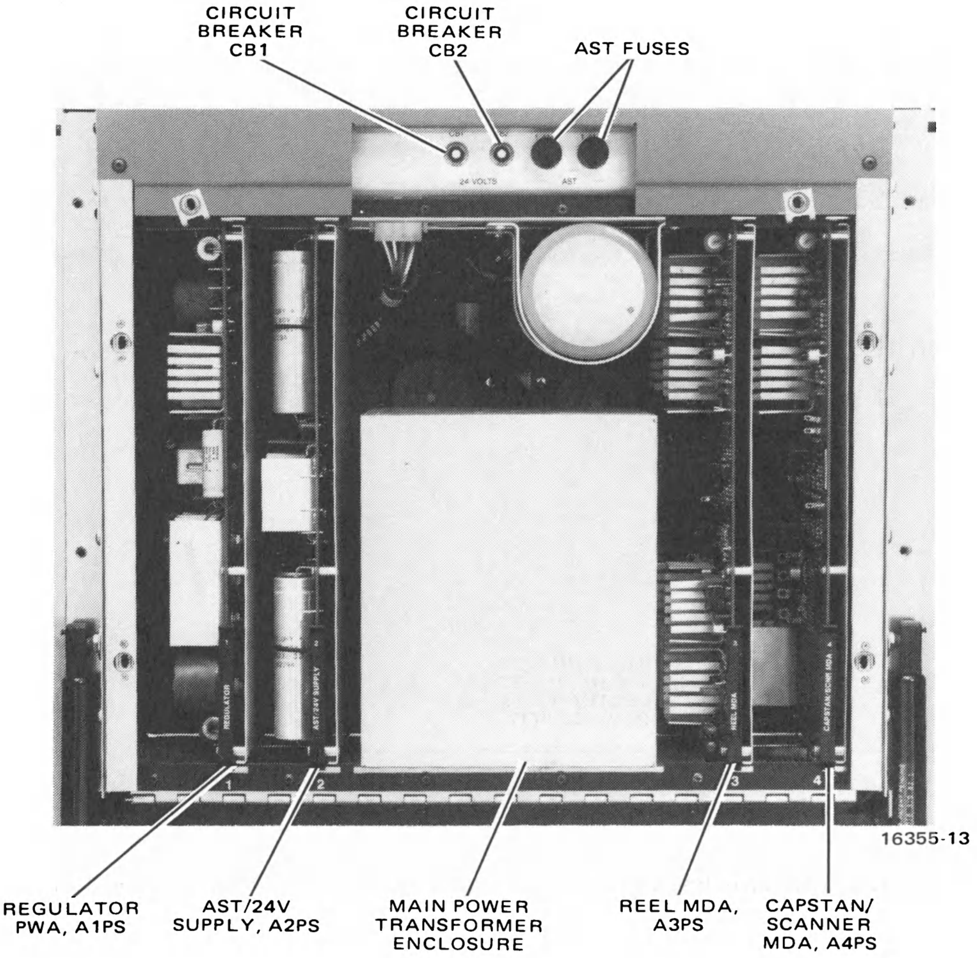


Figure 8-4. Power Supply Chassis, Cover Removed

WARNING

SAFETY GLASSES SHOULD BE WORN WHEN SERVICING POWER SUPPLY ASSEMBLIES. COMPONENTS CAN EXPLODE.

8-8 Power Supply Motherboard PWA Power Dump Threshold Detector Adjustment R16 and Circuit Breaker Trip Threshold Detect Adjustment R22

Power dump threshold detector adjustment R16 and circuit breaker trip threshold detect adjustment R22 are located on the Power Supply Motherboard PWA. Potentiometer R16 and R22 should be adjusted only if circuit breaker trip problems occur. Note that there is also a circuit breaker trip command from the control logic which can be disabled by removing jumper J12 on Control PWA 20. All referenced test points are on the power supply motherboard. Use a digital voltmeter for measurements, and adjust R16 and R22 as follows:

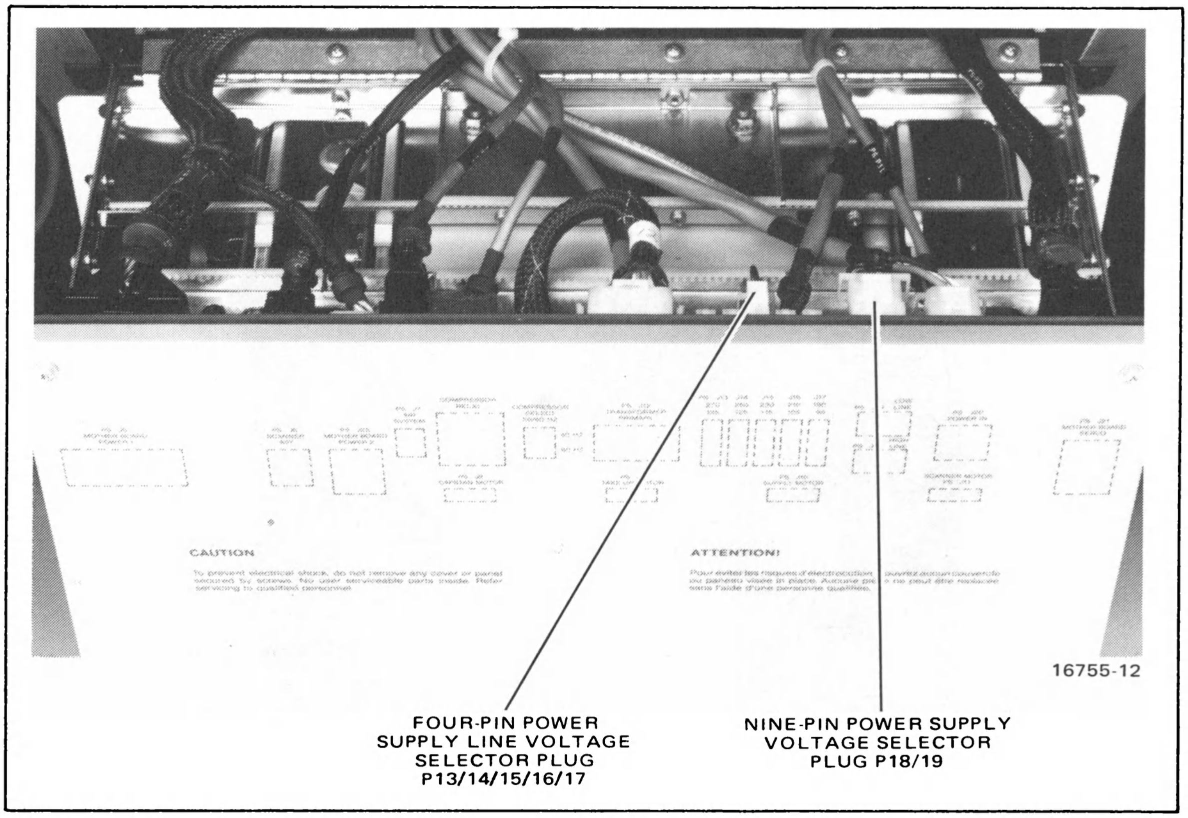

16755-12
FOUR-PIN POWER SUPPLY LINE VOLTAGE SELECTOR PLUG P13/14/15/16/17
NINE-PIN POWER SUPPLY VOLTAGE SELECTOR PLUG P18/19

Figure 8-5. Power Supply Voltage Selector Plugs Location

Table 8-1. Line Voltage Selector Plug P13/14/15/16/17 Placement Guide

Measured Line Voltage	Jack	
270 Vac	PS J13	Plug P18/19 must be in PS J18
250 Vac	PS J14	
230 Vac	PS J15	
210 Vac	PS J16	
190 Vac	PS J17	
135 Vac	PS J13	Plug P18/19 must be in PS J19
125 Vac	PS J14	
115 Vac	PS J15	
105 Vac	PS J16	
95 Vac	PS J17	

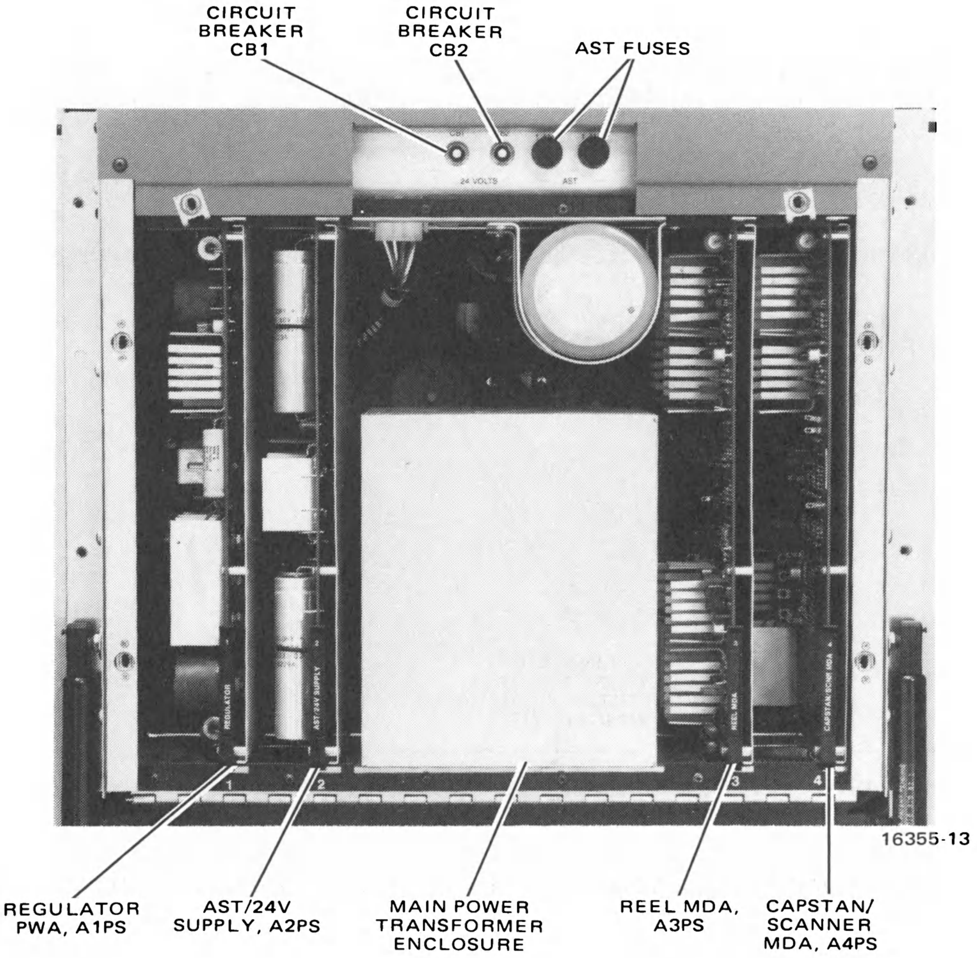


Figure 8-4. Power Supply Chassis, Cover Removed

WARNING

SAFETY GLASSES SHOULD BE WORN WHEN SERVICING POWER SUPPLY ASSEMBLIES. COMPONENTS CAN EXPLODE.

8-8 Power Supply Motherboard PWA Power Dump Threshold Detector Adjustment R16 and Circuit Breaker Trip Threshold Detect Adjustment R22

Power dump threshold detector adjustment R16 and circuit breaker trip threshold detect adjustment R22 are located on the Power Supply Motherboard PWA. Potentiometer R16 and R22 should be adjusted only if circuit breaker trip problems occur. Note that there is also a circuit breaker trip command from the control logic which can be disabled by removing jumper J12 on Control PWA 20. All referenced test points are on the power supply motherboard. Use a digital voltmeter for measurements, and adjust R16 and R22 as follows:

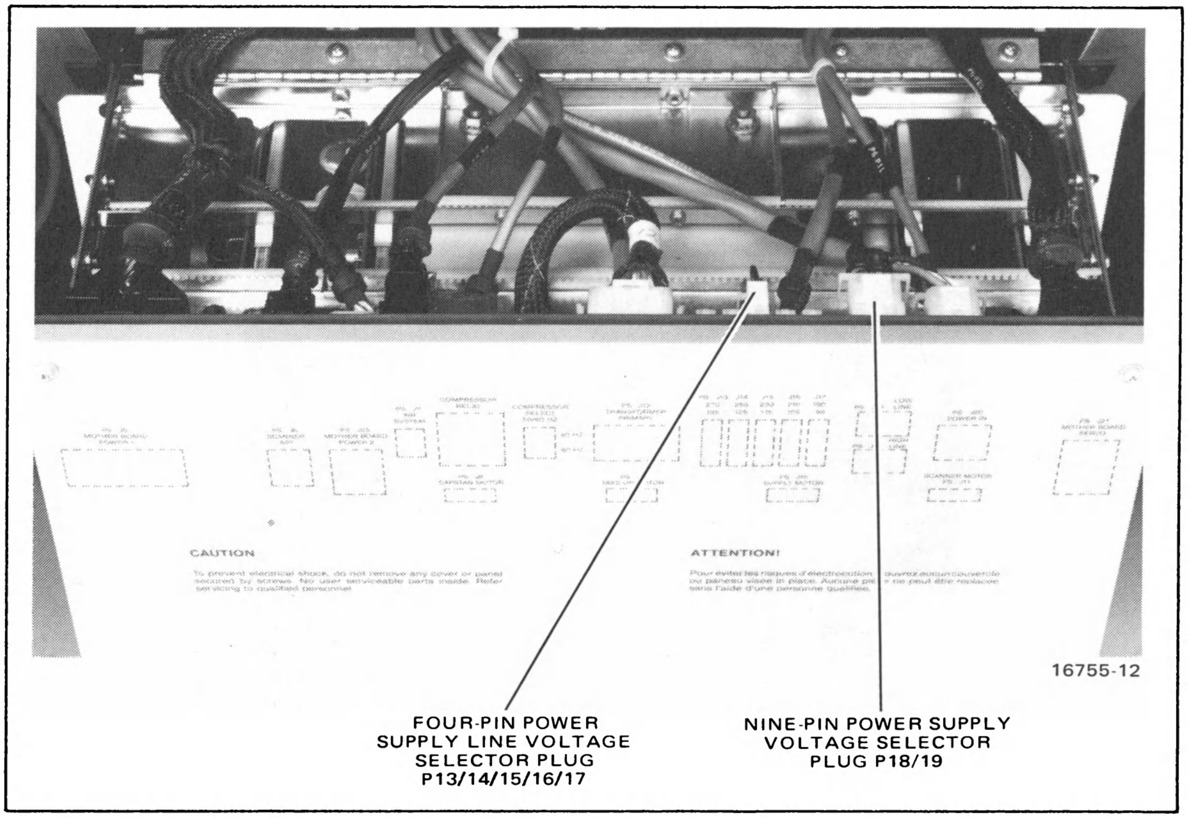

16755-12
FOUR-PIN POWER SUPPLY LINE VOLTAGE SELECTOR PLUG P13/14/15/16/17
NINE-PIN POWER SUPPLY VOLTAGE SELECTOR PLUG P18/19

Figure 8-5. Power Supply Voltage Selector Plugs Location

Table 8-1. Line Voltage Selector Plug P13/14/15/16/17 Placement Guide

Measured Line Voltage	Jack	
270 Vac	PS J13	Plug P18/19 must be in PS J18
250 Vac	PS J14	
230 Vac	PS J15	
210 Vac	PS J16	
190 Vac	PS J17	
135 Vac	PS J13	Plug P18/19 must be in PS J19
125 Vac	PS J14	
115 Vac	PS J15	
105 Vac	PS J16	
95 Vac	PS J17	

STEP 1 Turn VPR-3 power off. Remove Regulator, 24V Regulator/AST Driver, Reel MDA, and Capstan/Scanner MDA PWAs from power chassis.

Note

Steps 2 through 5 are based on the equation:

(TP4V)/(95) = (TP3V)/(R1V)

STEP 2 Turn VPR-3 power on. Refer to Figure 8-6 to aid in locating R1, and then measure the +70V supply across R1, and note it.

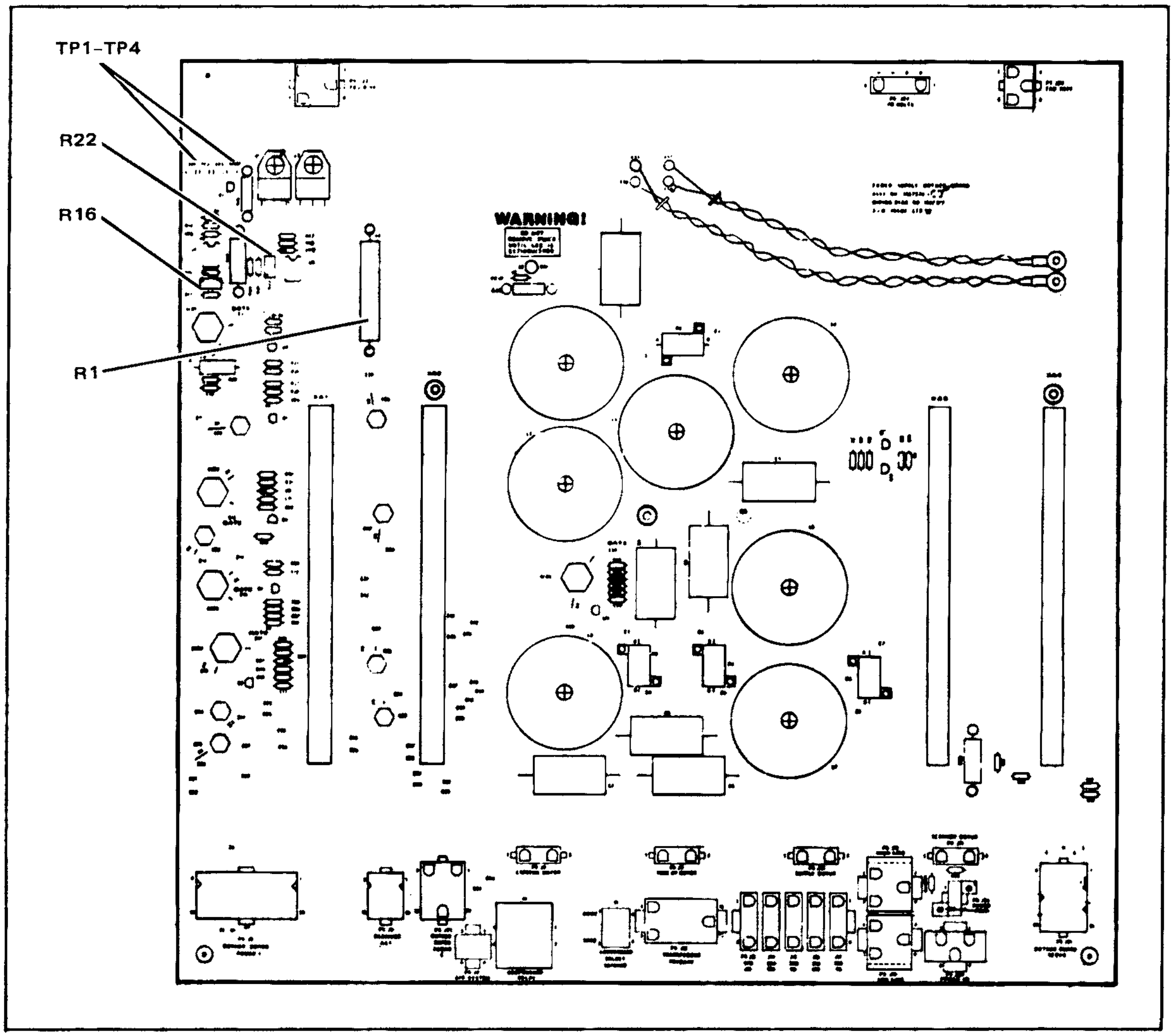


Figure 8-6. Power Supply Motherboard PWA Component Location Diagram

STEP 3 Measure voltage at TP4, and note it.

STEP 4 Multiply voltage measured across R1 by voltage at TP4, divide result by 95: [(R1 x TP4)/(95) = TP3], and note it.

STEP 5 Measure voltage at TP3. If necessary, adjust R22 on power chassis motherboard for voltage calculated in step 4. The following measurements were made on a typical VPR-3:

R1: 83.85V

TP3: 4.82V

TP4: 5.47V

Calculation: (83.85 x 5.47)/95 = 4.83 (TP3)

Note

Steps 6 through 8 are based on the equation:

(TP1V)/(R1V) = (TP2V)/(90)

STEP 6 Measure voltage at TP2, and note it.

STEP 7 Multiply voltage measured across R1 by voltage at TP2, divide result by 90 [(R1 x TP2)/(90) = TP1], and note it.

STEP 8 Measure voltage at TP1. If necessary, adjust R16 on the Power Supply Motherboard PWA for voltage calculated in step 7. The following measurements were made in a typical VPR-3:

R1: 83.85V

TP1: 5.84V

TP2: 6.28V

Calculation: (83.85 x 6.28)/90 = 5.85 (TP1)

8-9 Regulator PWA Dc-to-Dc Converter Adjustment R29

Adjust potentiometer R29 on Regulator PWA as follows:

STEP 1 Turn VPR power off. Use extender PWA to extend Regulator PWA from VPR.

STEP 2 Connect voltmeter to pin 19/20. Apply power. If voltmeter reading is not 6.1V ±50 mV, adjust R29. See Figure 8-7 for location of R29.

8-10 Low-Voltage Supply (+5, +12V, and -12V) Checks and Adjustment

Low-voltage supplies (+5, +12V, and -12V) are checked at front electronics bay using PWA extender and, if necessary, adjustments to the power supply are made on the Regulator PWA which is extended from the Power Supply Motherboard PWA. These checks and adjustments should be done after performing the procedure in paragraph 8-9.

Note

If diagnostic option is installed, power supply voltages can be monitored via control panel fluorescent display.

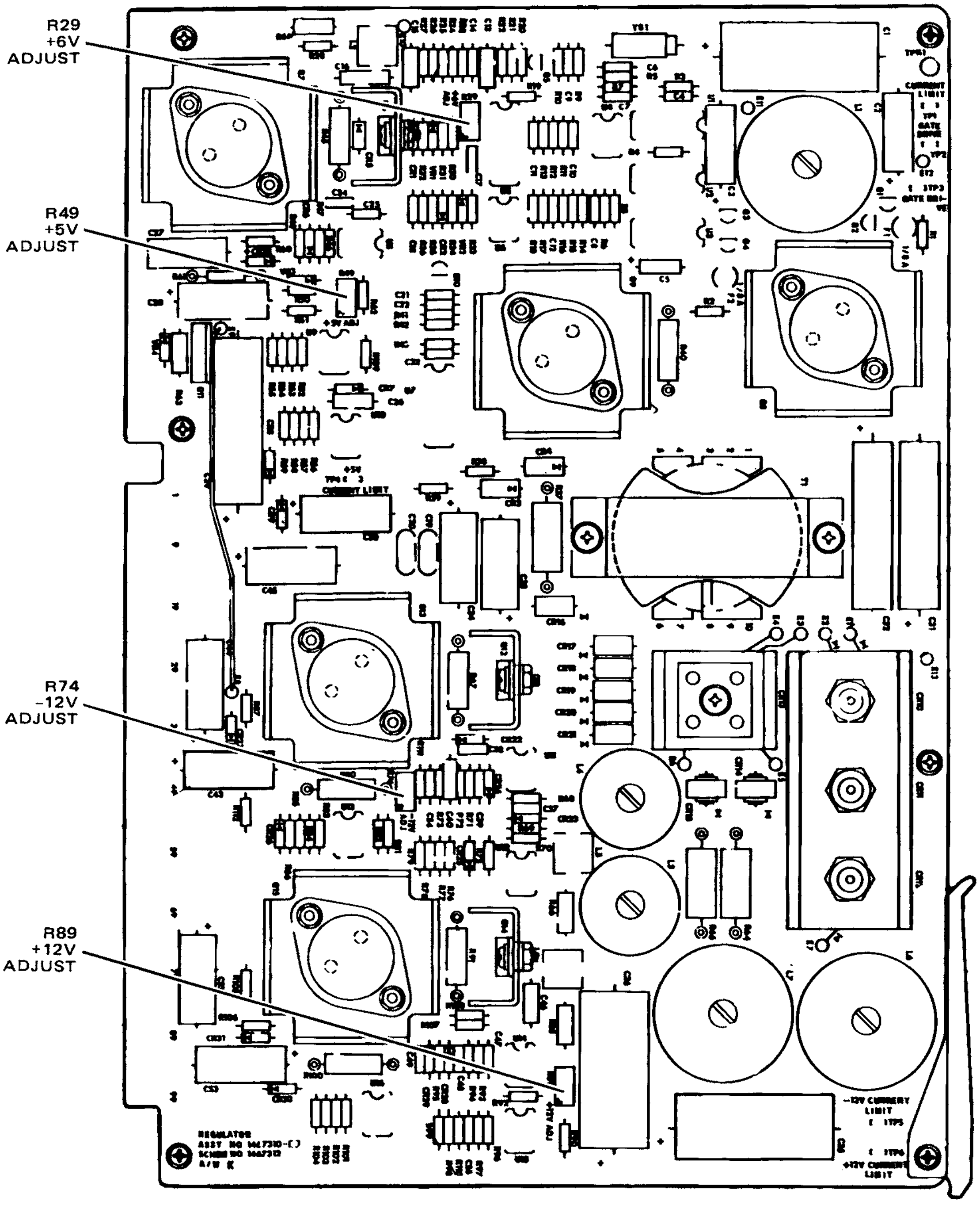


Figure 8-7. Regulator PWA Component Location Diagram

To check +5 Vdc proceed as follows:

STEP 1 Place PWA extender into electronics bay slot 13 (spare) at the front of the VPR, and connect voltmeter to pin 99/100. Turn on power. Read +5V ±10 mV.

STEP 2 If necessary, adjust R49 on Regulator PWA for +5V %2 mV.

To check +12 Vdc proceed as follows:

STEP 1 Turn VPR power off. Remove Autochroma PWA from electronics bay slot 4.

STEP 2 Place extender into slot 4 (Autochroma PWA). Do not install Autochroma PWA on extender. Connect voltmeter to pin 1/2. Turn on power. Read +12V ±10 mV.

STEP 3 If necessary, adjust R89 on Regulator PWA for +12V ±2 mV.

To check -12 Vdc proceed as follows:

STEP 1 With extender in slot 4 (Autochroma PWA, Autochroma PWA not mounted on extender), connect voltmeter, pin 5/6 of extender. Read -12V ±10 mV.

STEP 2 If necessary, adjust R74 on Regulator PWA for -12V ±2 mV.

STEP 3 Turn power off, remove extender, and replace Autochroma PWA.

8-11 Low-Voltage Supply (+13V, and -13V) Checks

To check +13V and -13V voltages proceed as follows:

STEP 1 Turn VPR power off. Remove Reel and Scanner Servo PWA 14 from electronics bay. Install extender into electronics bay slot 14. Do not install Reel and Scanner Servo PWA on extender.

STEP 2 Turn power on and measure voltages at pins on extender PWA as indicated below. There are no adjustments.

+13 Vdc: pin 1/2 = +12.8 to +15 Vdc
-13 Vdc: pin 5/6 = -12.8 to -15 Vdc
Servo +5: pin 99/100 = +5V ±100 mV

8-12 Regulator PWA, A1 P/S, Assembly No. 1467310

Procedures for adjusting Regulator PWA, A1 P/S, Assembly No. 1467310 are given in paragraphs 8-9 and 8-10.

8-13 24 Volt Regulator/AST Driver PWA, A2 P/S, Assembly No. 1467320

Adjust potentiometer R33 as follows:

STEP 1 Turn VPR power off. Remove 24 Volt Regulator/AST Driver PWA, A2 P/S from power supply chassis. Install extender into power supply bay slot 2. Install 24 Volt Regulator/AST Driver PWA.

STEP 2 Turn power on. Measure voltage at TP1. Read +5V ±10mV. See Figure 8-8.

STEP 3 If necessary, adjust R33 on 24 Volt Regulator/AST Driver PWA for +5V ±10mV at TP1.

STEP 4 Turn power off, remove extender, and replace 24 Volt Regulator/AST Driver PWA in power suppply chassis.

8-14 Power Supply Motherboard PWA, Assembly No. 1467370

Procedures for adjusting the Power Supply Motherboard PWA, Assembly No. 1467370 are given in paragraphs 8-8.

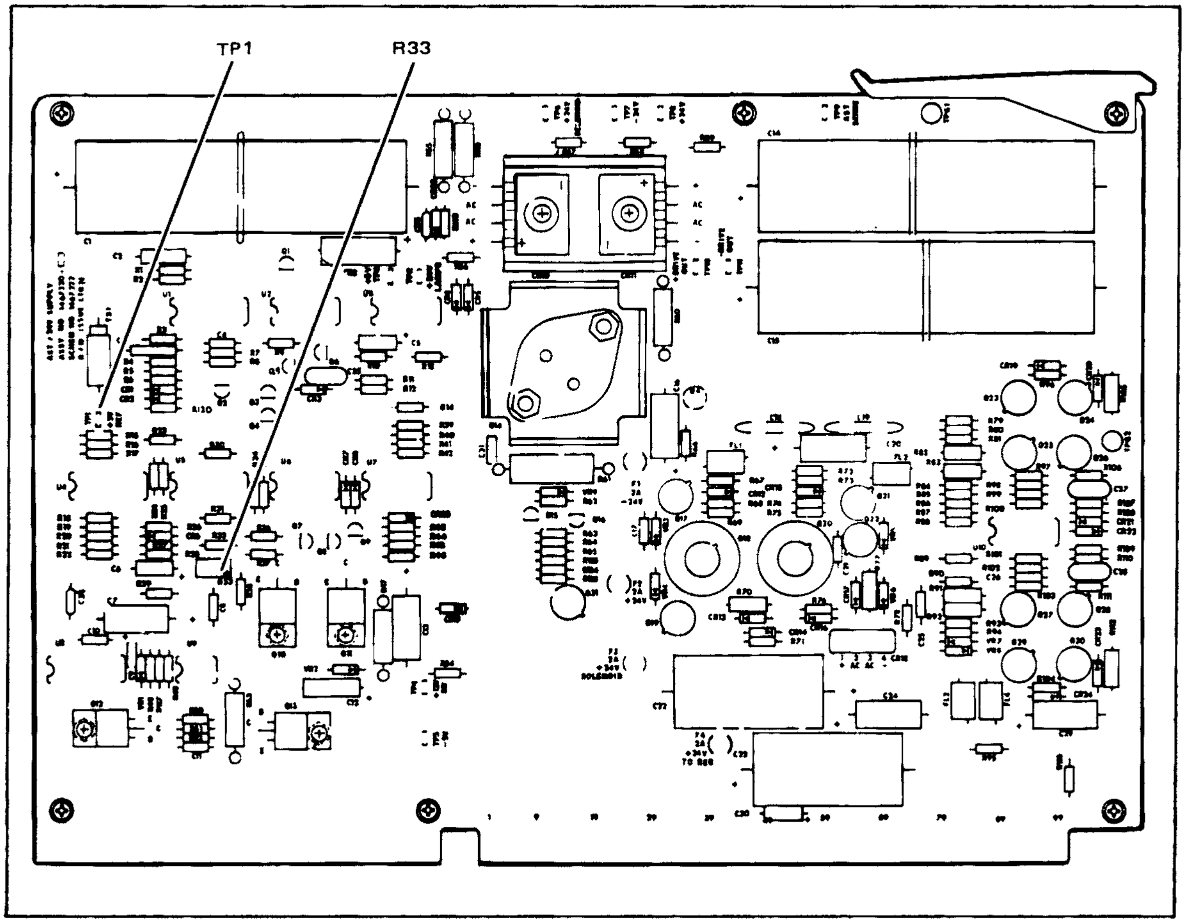


Figure 8-8. 24-Volt Regulator/AST Driver PWA Component Location Diagram

SECTION 9

AIR SYSTEM

9-1 INTRODUCTION

This section describes the VPR-3 air system, which is an integral part of the tape transport system. The section includes theory of operation, adjustment procedures, and troubleshooting. An overall system block diagram as well as applicable photographs and drawings are included.

9-2 GENERAL SYSTEM DESCRIPTION

The air system, located behind the tape transport, serves two main functions:

- It creates an air vacuum between tape and capstan, drawing tape to the capstan.
- It supplies air flow to tiny air passages in the tape guides and tension arms, producing an air film between tape and metal surfaces that substantially reduces friction.

The air system also provides increased vacuum tension for the supply tension arm during tape rewind, and supplies air pressure for the air-activated audio headstack shield. This shield slides into position when VPR-3 power is on and tape is threaded.

An ac-powered rotary-vane type compressor, located in an acoustically shielded enclosure, produces both vacuum and air pressure. An air-flow regulator relief valve controls air to the scanner guides, and a pressure regulator controls air to the tape transport guides, takeup, and tension arms. A valve is used to adjust the vacuum to the capstan. The system uses three air filters to prevent clogging of air passages. One filters the air drawn in through the capstan, one filters the air output from the compressor, and a third, in-line filter, filters air to the scanner guides.

9-3 THEORY OF OPERATION

The following paragraphs describe the compressor, the capstan vacuum, and the air pressure system. An overall block diagram of the air system is shown in Figure 9-1. A rear view of the VPR-3 showing air system components is shown in Figure 9-2.

9-4 Compressor

The heart of the air system is a rotary carbon-vane compressor housed in an acoustically shielded box. Air drawn into the compressor provides vacuum for the capstan, and air flowing out provides pressure to the scanner tape air guides and tension arms. A resonator on the outlet line (located in the box) reduces air modulation pulses.

The compressor is powered by 115 Vac, 60 or 105 Vac, 50 Hz. A 100-cfm (cubic feet per minute) fan supplies cooling air for the compressor motor. In the event the motor overheats, a temperature switch will close at 149°F (65°C), causing a fault condition message to be displayed on the control panel. As a backup safety precaution, a second switch will shut down the compressor if the temperature should reach 185°F (85°C).

9-5 Vacuum System

Air drawn through holes in the capstan drum creates a suction to pull the tape onto the capstan. A vacuum line connects the capstan to the vacuum manifold, where the vacuum is maintained at 70 inches of water by an adjustable valve. Filtered air to the valve is obtained from a pressure-tap on the scanner air-flow regulator relief valve. A vacuum pressure of less than 10 inches of water will close the vacuum-actuated switch, causing a fault condition message to be displayed on the control panel. Closing the switch will also shut down the system if the tape is moving faster than five times play speed.

For added tension during tape rewind, a three-way electrical valve operates, pulling a vacuum on the dashpot. The dashpot is connected to the supply tension arm. When the valve is not operated, the dashpot vacuum line is open to atmospheric pressure.

The compressor input filter is replaceable, and removes 93% of all 0.1-micron particles and virtually 100% of all larger and smaller particles. If the filter becomes clogged, a pressure switch connected across the filter will close at a pressure differential of 10 inches of water. Switch closure will result in a fault message displayed on the control panel.

9-6 Air Pressure System

Compressor output air passes through a replaceable filter which removes 98% of all 0.1-micron particles and virtually 100% of all larger and smaller particles. If the filter becomes clogged, a pressure switch connected across the filter will close at a pressure differential of 10 inches of water. Switch closure results in a fault message displayed on the control panel. System pressure is indicated on the flow regulator relief valve pressure gauge, and is normally between 6 to 8 psi.

9-7 Scanner Guide Air

The air-flow regulator relief valve controls air to the scanner guides. The regulator is set for 1 to 1.25 scfh (standard cubic feet per hour) as read on the flow gauge. At normal air flow conditions, the air-flow regulator pressure gauge should read between 6 to 8 psi in playback mode.

A pressure tap from the flow regulator provides air to the air-actuated audio headstack shield. During playback modes, the three-way electrically actuated valve operates the shield. When not operated, the valve is open to atmospheric pressure. Make-up air for vacuum relief is taken from the flow regulator bleed to atmosphere.

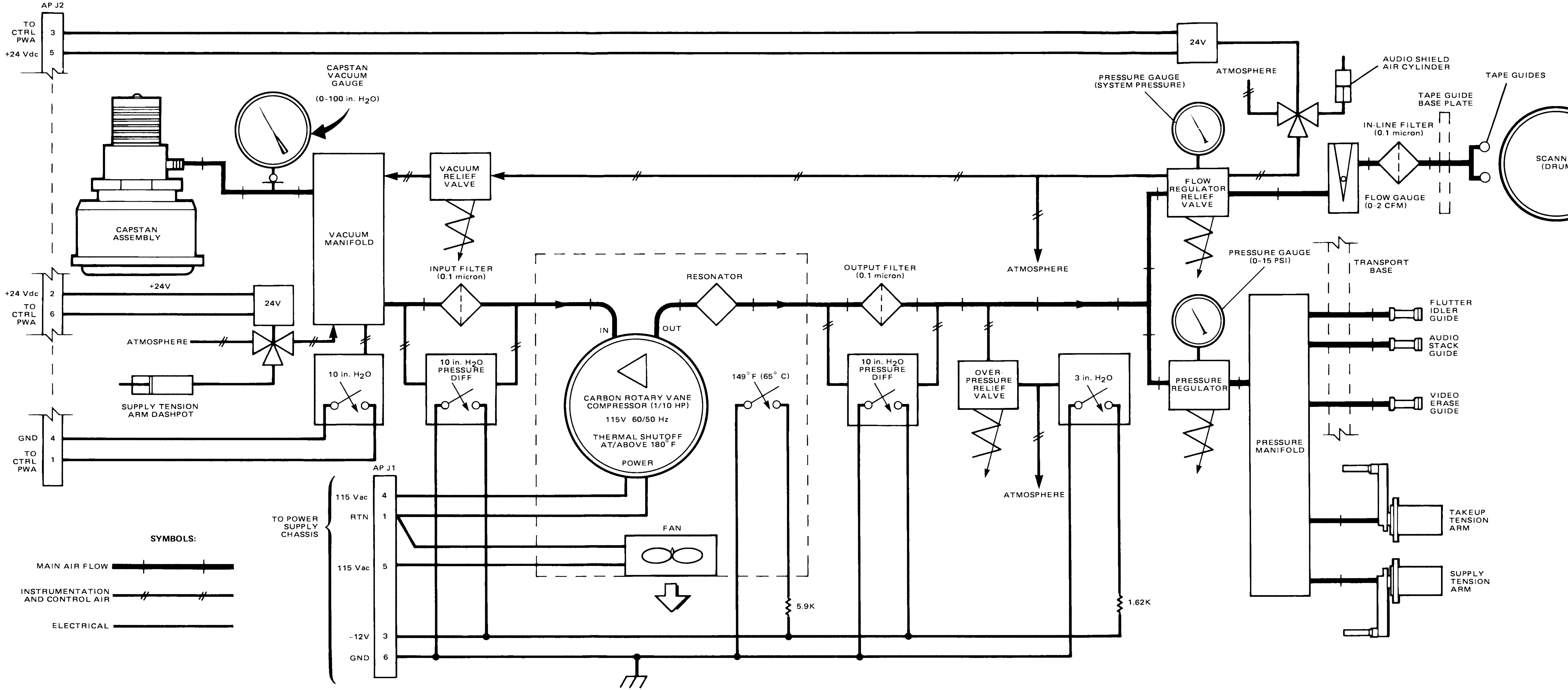


Figure 9-1.
VPR-3 Air System Block Diagram

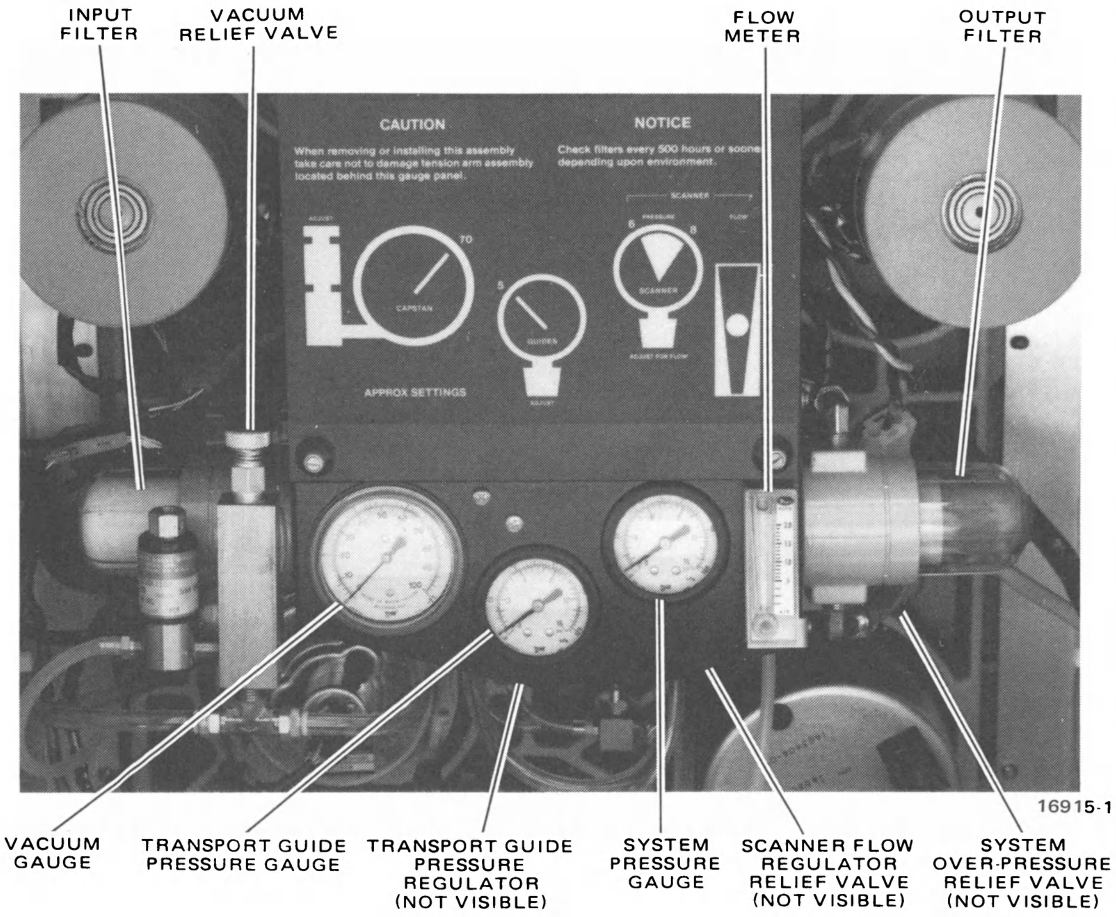

INPUT FILTER
VACUUM RELIEF VALVE
FLOW METER
OUTPUT FILTER
CAUTION
NOTICE
16915-1
VACUUM GAUGE
TRANSPORT GUIDE PRESSURE GAUGE
TRANSPORT GUIDE PRESSURE REGULATOR (NOT VISIBLE)
SYSTEM PRESSURE GAUGE
SCANNER FLOW REGULATOR RELIEF VALVE (NOT VISIBLE)
SYSTEM OVER-PRESSURE RELIEF VALVE (NOT VISIBLE)

Figure 9-2. Air System

A replaceable in-line filter, located between the flow meter and the scanner guides, removes 99.995% of all remaining 0.1 micron particles, and virtually 100% of all larger and smaller particles.

9-8 Tape Transport Guides and Tension Arms Air

Air to the guides and tension arms is controlled by a pressure regulator, which is adjusted for 5 psi as read on the pressure gauge. The air pressure manifold distributes the air to the video erase stack, audio stack, and flutter idler guides, and to the takeup and supply tension arm guides.

9-9 Fault Monitoring

The vacuum, filter differential pressure, over-pressure, and compressor over-temperature switches are connected to -12V voltage divider. Depending on switch closure, a voltage level is sent out on pin 3 of connector J1 to the control panel PWA, where it is processed to display the corresponding fault message.

9-10 MAINTENANCE

The following paragraphs furnish procedures for periodic replacement of air filters, and adjustment of vacuum, air flow, and air pressure. Diagnostic troubleshooting and localization of problem areas is included. Refer to Figure 9-2 for locations of various air system components.

9-11 Air Filter Replacement

Input and output filters should be inspected monthly and changed every 5000 hours of VPR-3 operation. However, the diagnostic display will indicate when it is time to replace filters, depending on cleanliness of environment air. Check filter assembly glass bowls for excessive dust, dirt, and carbon deposits. It is normal for the output filter to become black due to carbon dust from compressor vanes. Replace both filters when either filter is changed. The in-line filter should never need changing.

Replace air system filters as follows:

STEP 1 Turn off power to the VPR-3.

STEP 2 Loosen and remove four screws (see Figure 9-3) that fasten VPR power supply chassis to housing frame.

WARNING

THE POWER SUPPLY IS HEAVY; BE PREPARED FOR THIS.

STEP 3 Carefully swivel hinged power supply chassis down and out of the housing frame until it rests as shown in Figure 9-4.

WARNING

MAKE SURE THE POWER SUPPLY MOTHERBOARD SHIELD IS INSTALLED: HIGH VOLTAGE IS PRESENT IN MANY AREAS OF THE POWER SUPPLY MOTHERBOARD, AND IT WILL BE NECESSARY TO LEAN OVER THE MOTHERBOARD TO CHANGE FILTERS OR ADJUST AIR REGULATORS WHILE POWER TO THE VPR IS TURNED ON.

STEP 4 Locate air system filters (refer to Figure 9-2).

STEP 5 Unscrew transparent filter bowl on input and output filter assembly.

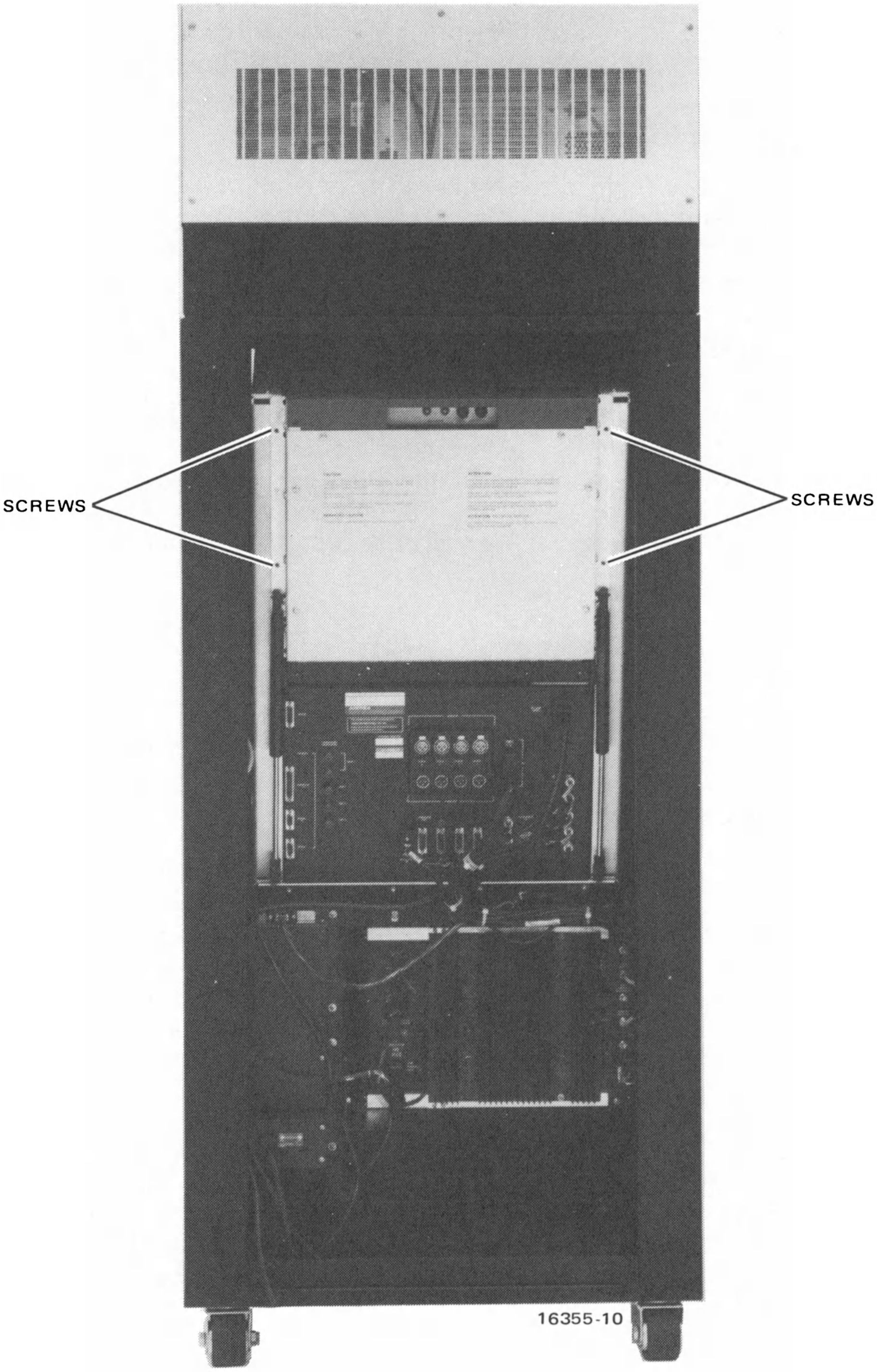


Figure 9-3. VPR-3 Power Supply Chassis Fastened in Frame

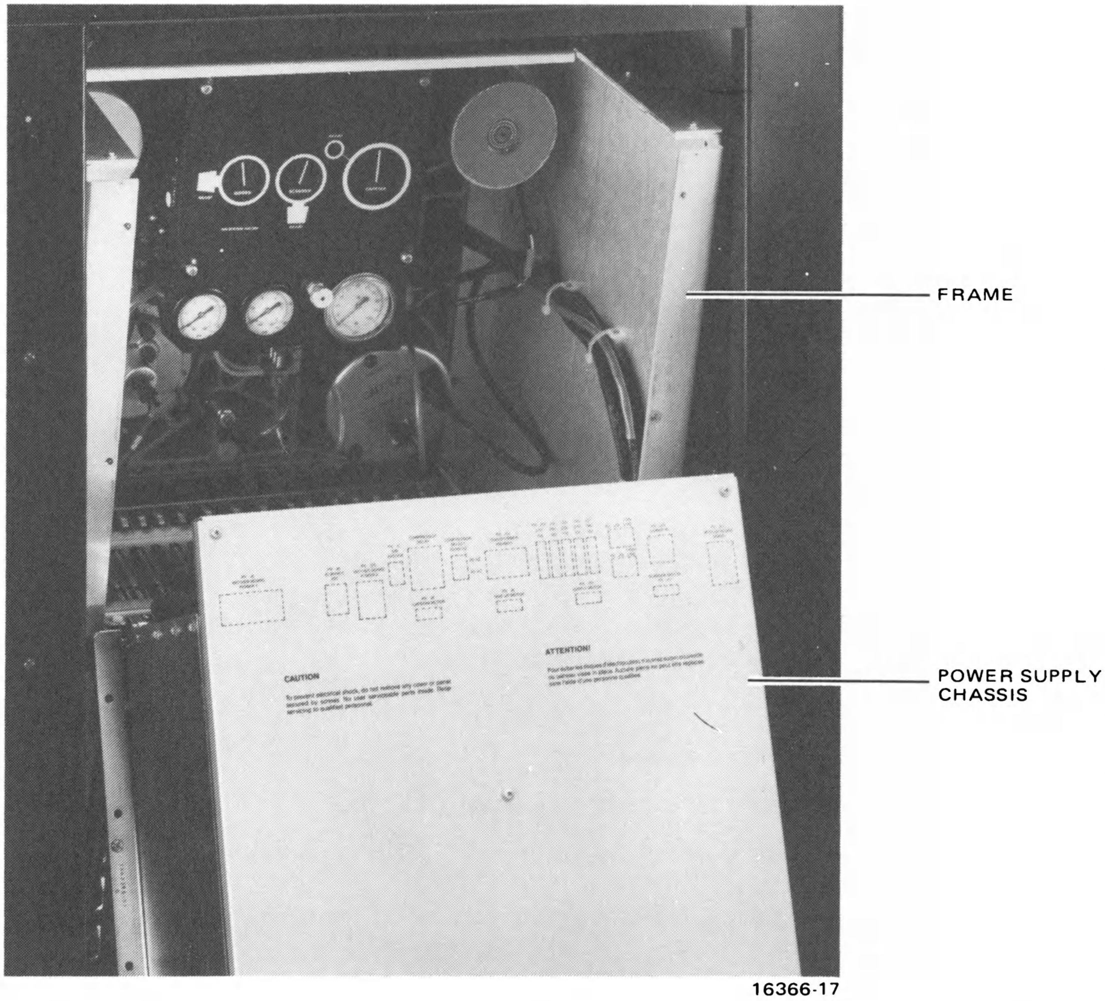


Figure 9-4. VPR-3 Power Supply Chassis Lowered Out of Frame

STEP 6 Remove dirty filter element.

STEP 7 Wipe bowl and other parts of filter assembly clean.

STEP 8 Install the following filter elements:

Input—Ampex Part No. 052-052 (Balston, pn 100-12, grade 242)

Output—Ampex Part No. 052-051 (Balston, pn 100-12)

Make sure 0-ring is placed on filter bowl lip. Secure filter by screwing bowl into filter assembly.

In-line (not normally necessary to replace)—
Ampex Part No. 052-055 (Balston, pn 9900-05 BK)

STEP 9 Turn on power to VPR-3 and verify compressor starts. Check for leaks around filter bowls and hose connections.

Note

If no tape is on the machine, the compressor can be started by moving supply tension arm to its tensioned position. It can be held in place by using a large rubber band between the arm and a stationary tape guide.

STEP 10 Place VPR-3 in ready mode, and adjust system over-pressure as follows:

a. Locate relief valve mounted above scanner and behind output filter.

b. Rotate relief valve knob ccw until tape guide pressure falls to zero.

c. Pinch scanner hose near in-line filter to prevent flow to scanner guides.

d. Rotate relief valve knob cw until scanner guide pressure reaches 13.0 psi. Release hose. Push lock ring at base of knob.

STEP 11 Verify following vacuum, flow, and pressure readings. Tape must be tensioned for proper air system readings.

a. Vacuum gauge—70 ±5 inches of water

b. Scanner air flow gauge—1.0 to 1.25 scfm

c. System air pressure gauge—7.0 psi ±1.0 psi

d. Transport guide pressure gauge—5.0 psi +1, -0 psi

If any of the above readings are out of tolerance, perform air system adjustment procedure.

9-12 Air System Adjustment

The following procedure should be done in the sequence shown to minimize regulator adjustment interaction.

Proceed as follows:

STEP 1 Tilt down power supply chassis at console rear (refer to steps 2 and 3 of paragraph 9-11).

STEP 2 Thread on roll of work tape and push READY then PLAY buttons on the control panel. Air compressor will start and tape should tension up. Tape must be tensioned for proper air system adjustment.

STEP 3 Adjust system over-pressure as follows:

a. Locate relief valve mounted above scanner and behind output filter.

b. Rotate relief valve knob ccw until tape guide pressure falls to zero.

c. Pinch scanner hose near in-line filter to prevent flow to scanner guides.

d. Rotate relief valve knob cw until scanner guide pressure reaches 13.0 psi. Release hose. Push lock ring at base of knob.

STEP 4 Adjust vacuum relief valve for a reading of 70 ±5 inches of water as read on the vacuum meter.

Note

Vacuum gauge pointer will not be steady, but will be fluctuating at a rate related to once-around of the capstan.

STEP 5 Adjust scanner flow regulator relief valve for a reading of 1.0 to 1.25 scfh as read on flow gauge. For accuracy, adjustment should be approached from the low end of the scale. To reset, proceed as follows:

a. Turn adjustment knob full ccw.

b. Pinch air hose near in-line filter, and verify that flow regulator pressure gauge reading increases to approximately 12 psi.

c. Release hose, and adjust air flow regulator cw until correct flow reading is obtained.

d. Verify scanner pressure is 6 to 8 psi.

STEP 6 Adjust transport guide pressure regulator for 5 psi +1, -0 psi as read on pressure gauge.

STEP 7 Pressure and flow regulators interact; therefore, recheck readings and readjust as necessary.

9-13 Troubleshooting

The VPR-3 contains continuous software diagnostics to aid the service technician in troubleshooting. Four possible air system faults are monitored and displayed as fault messages on the control panel. Listed with low priority first, they are as follows:

air pressure high

air filters dirty

compressor over temp

compressor fail

The following paragraphs describe the corresponding detected failure, and suggest possible action to be taken. Refer to Figures 9-2 and 9-5 for air system component location. The VPR-3 should be on and in play mode for proper checks.

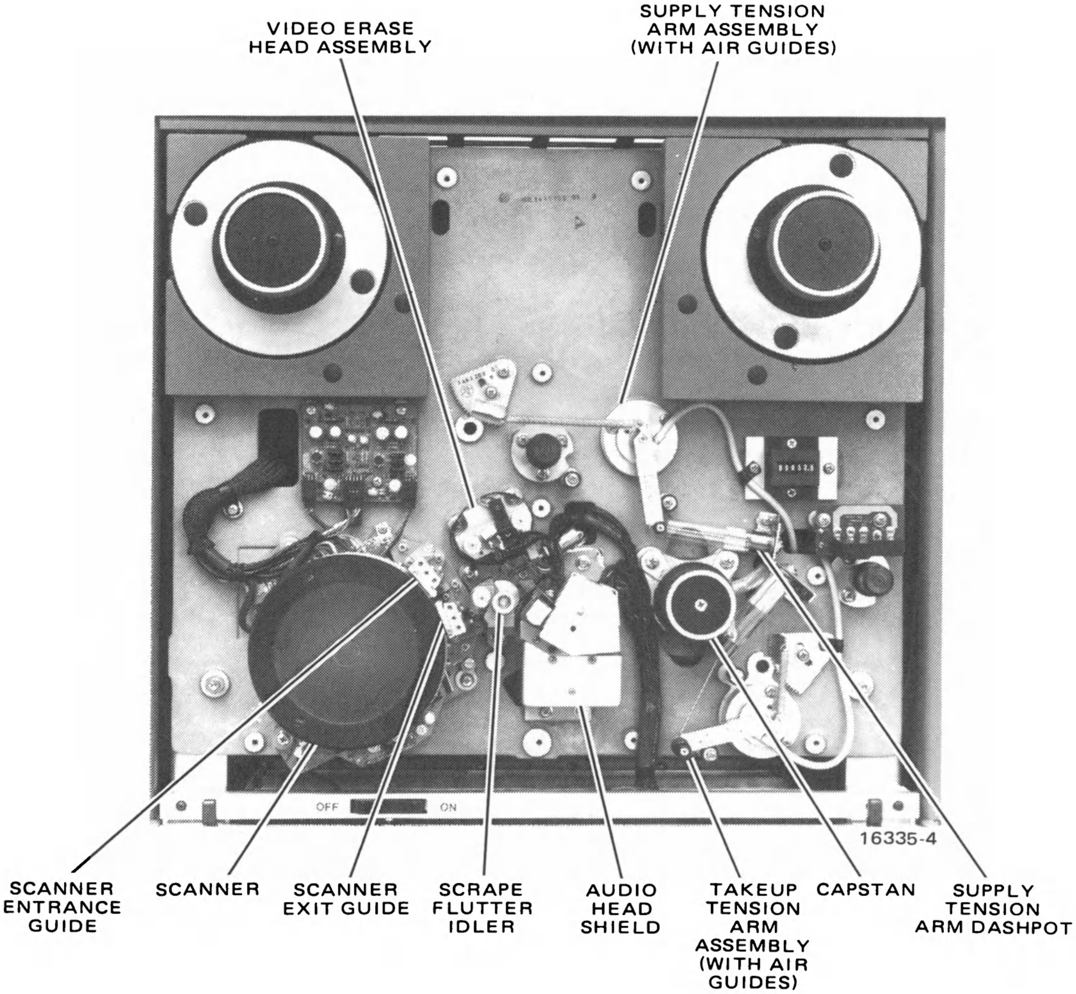

VIDEO ERASE HEAD ASSEMBLY
SUPPLY TENSION ARM ASSEMBLY (WITH AIR GUIDES)
OFF
ON
16335-4
SCANNER ENTRANCE GUIDE
SCANNER
SCANNER EXIT GUIDE
SCRAPE FLUTTER IDLER
AUDIO HEAD SHIELD
TAKEUP TENSION ARM ASSEMBLY (WITH AIR GUIDES)
CAPSTAN
SUPPLY TENSION ARM DASHPOT

Figure 9-5. VPR-3 Transport Air System

9-14 Air Pressure High

The display **air pressure high** on control panel indicates that system air pressure is above 13 psi. Check the following:

- Flow regulator pressure gauge reads approximately 13 psi.
- Pinched air hose between regulator and scanner guides.
- Clogged scanner guides.
- Clogged in-line filter; replace if necessary.
- Electrical fault in diagnostics monitoring system.

9-15 Air Filters Dirty

The display **air filters dirty** indicates that pressure differential across the output or input filter is above 10 inches of water. Check for dirty filters, and replace as necessary. Recheck the following air system readings, and adjust as necessary.

- Vacuum—70 ±5 inches of water
- Air flow—1.0 to 1.25 scfh
- Scanner pressure (system pressure)—7 psi ±1.0 psi
- Guide pressure—5 psi ±1, -0 psi

9-16 Compressor Over-Temperature

The display **compressor over temp** indicates that compressor temperature is above 149°F (65°C). Check the following:

- Cooling fan for proper operation.
- Clogged input or output filters. Replace as necessary.
- High vacuum or pressure.
- High power line voltage.
- Defective compressor.

9-17 Compressor Fail

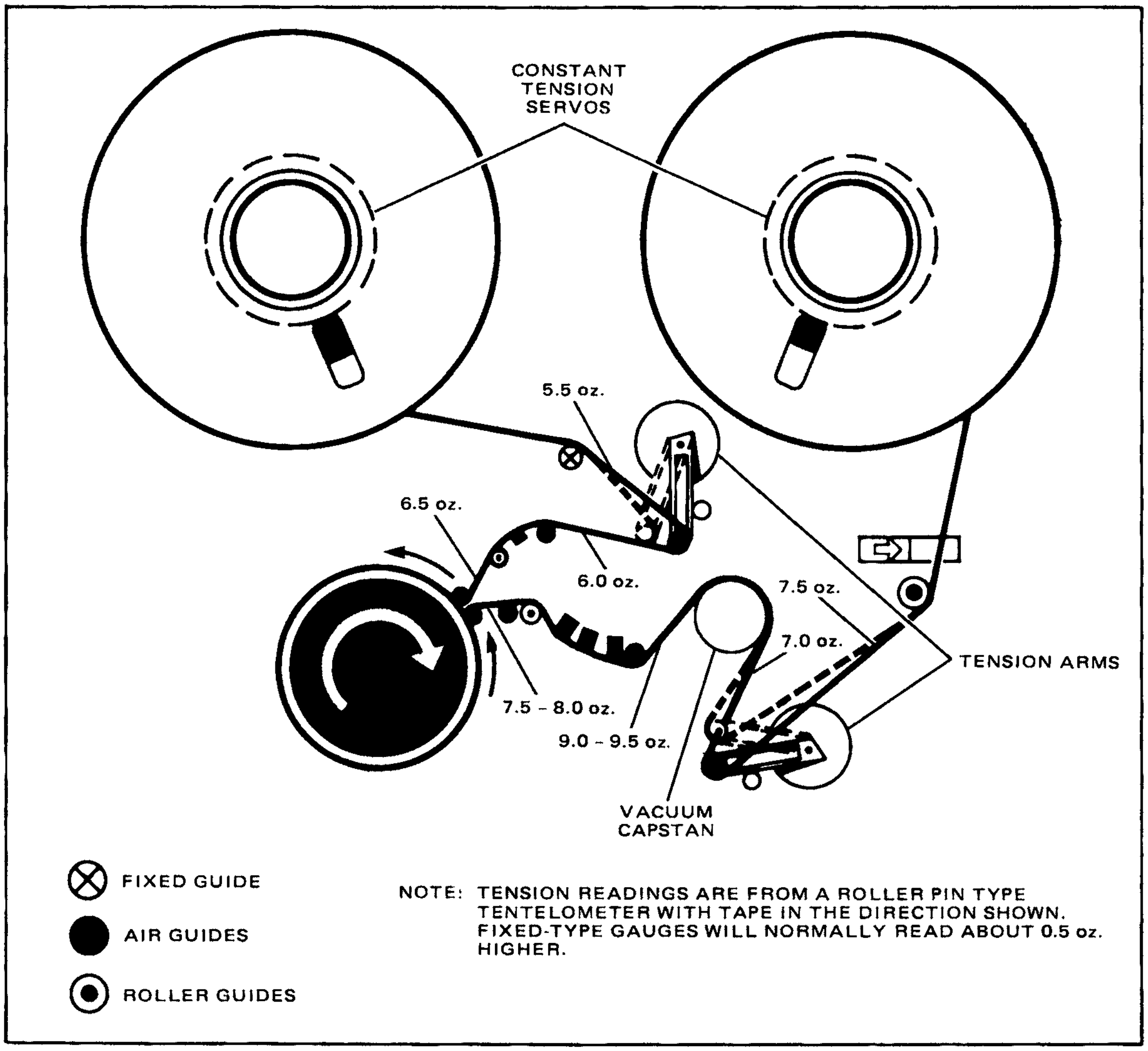
The display **compressor fail** on control panel indicates that capstan vacuum has fallen below 10 inches of water. Check the following:

- Compressor is operating.
- Vacuum gauge reading of 70 ±5 inches of water. If necessary, adjust vacuum valve.
- Dirty filters. If necessary, replace filter elements.
- Disconnected or loose vacuum hoses at or between capstan, vacuum manifold, tension-arm dashpot, or input air filter.
- Defective vacuum switch.
- Electrical fault in diagnostics monitoring system.

9-18 Localizing Air Flow Problems

A good indication of problems in the air pressure system is high capstan current. Capstan current can be observed using the servo diagnostics menu on control panel. Normal current in play mode is -0.6A to -0.9A. A high reading of +1.2A could indicate bad tape, or a possible air leak or blockage.

To localize the problem to individual tape guides and tension arm circuits, measure tape tension entering and leaving air guides using a tentelometer. See Figure 9-6 for normal tension readings. A high tape tension differential across a particular guide or guides could indicate increased tape friction resulting from the air flow problem.



NOTE: TENSION READINGS ARE FROM A ROLLER PIN TYPE TENTELOMETER WITH TAPE IN THE DIRECTION SHOWN. FIXED-TYPE GAUGES WILL NORMALLY READ ABOUT 0.5 oz. HIGHER.

Figure 9-6. Tape Tension

If a problem is suspected in the tension arm and tape guide air circuits, check for leaks around hose connections, pinched air hose, or clogged air passages in the guides and tension arms.

If a problem is suspected in the scanner guide circuit, check system pressure and flow gauge readings. A low system pressure (less than 6 psi) and a normal or high flow gauge reading (more than 1.2 scfh) could indicate a leak between flow gauge and scanner guides. A low flow gauge reading (less than 1.0 scfh) could indicate a leak between regulator and flow gauge. Check air hose connections, and check for a cracked flow gauge.

A high system pressure reading (above 8 psi), and a normal or low flow gauge reading could indicate an air blockage between regulator and scanner guides. Check for clogged in-line filter, pinched hose, or clogged air passages in scanner guides.

APPENDIX

PARTS LIST AND MAINTENANCE INFORMATION FOR GAST 1531 SERIES OIL-LESS COMPRESSOR (AMPEX P/N 1461381-02)

OPERATING and MAINTENANCE INSTRUCTIONS

CAUTION

NEVER LUBRICATE THIS OIL-LESS AIR PUMP. THE CARBON VANES AND GREASE-PACKED MOTOR BEARINGS REQUIRE NO OIL. ROTOR IS HELD IN PLACE WITH LOCTITE ADHESIVE. DO NOT REMOVE.

- **Starting:** If motor fails to start or hums, pull plug and check motor nameplate ratings and wiring diagram. If anything appears to be wrong with the motor, return complete pump and motor assembly to factory.

WARNING

THE MOTOR MAY BE THERMALLY PROTECTED AND CAN AUTOMATICALLY RESTART WHEN THE PROTECTOR RESETS. *ALWAYS* DISCONNECT POWER SOURCE BEFORE SERVICING.

- **Flushing:** Should excessive dirt, foreign particles, moisture, or oil be permitted to enter the pump, vanes will act sluggish or even break. Flushing of the pump should take care of these situations. In order to flush a pump, remove filter and muffler assemblies, and introduce several teaspoons full of solvent into the pump through the intake while the pump is running. Repeat flushing procedure if it does not remedy the situation, and remove end plate for further examination. Flush unit in a well-ventilated area. Eye protection is recommended. Keep face away from exhaust port and do not flush unit with flammable solvent.
- **Filters:** Dirty filters restrict air flow and if not corrected could lead to possible motor overloading and early pump failure. Check filters periodically, and clean when necessary by removing felts from the filter and washing in a solvent*. Dry with compressed air and replace.
- **Disassembly:** Remove the three screws which attach retainer plate to body. Now remove retainer plate and carbon wear plate to gain access to the vanes. Use compressed air to clean out pump chamber, especially if vanes are broken. Carbon wear plates have two usable sides. When one side is

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* Recommended Solvent: Gast Flushing Solvent Part No. AH255. DO *NOT* USE KEROSENE or any other flammable solvents.

worn, simply flip it over but use it on the same end of the pump. Do not remove the rotor since it is held in place by Loctite and should only be serviced by an authorized service facility. To reset clearance between rotor top and top of body bore, only loosen screws that attach body to electric motor. Do not remove body of pump because an exact factory determined body spacer gasket provides necessary clearance. After screws are loosened, place a 0.001 feeler gauge between the rotor top and the body, holding body in position while the body bolts are tightened. Withdraw feeler gauge and rotate rotor to be sure all points clear the bore.

- **Reassembly:** Simply place carbon plate and retainer plate in position, and add and tighten the three end plate screws. Should pump still fail to produce proper vacuum or pressure, send to authorized service center for repairs.

WARNING

TO PREVENT EXPLOSIIVE HAZARD, DO NOT PUMP COMBUSTIBLE LIQUIDS OR VAPORS WITH THESE UNITS.

If unit requires more than installation of a service kit, it is usually quickest and least expensive to send the unit in for repair. All returns are F.O.B. Benton Harbor, Michigan.

Authorized service facilities are located at:

Gast Manufacturing Co., Ltd.
Halifax Road, Cressex Estate
High Wycombe, Bucks HP12 3SN
England
High Wycombe 23571

Gast Manufacturing Corp.
2550 Meadowbrook Road
Benton Harbor MI 49022
616/926-6171

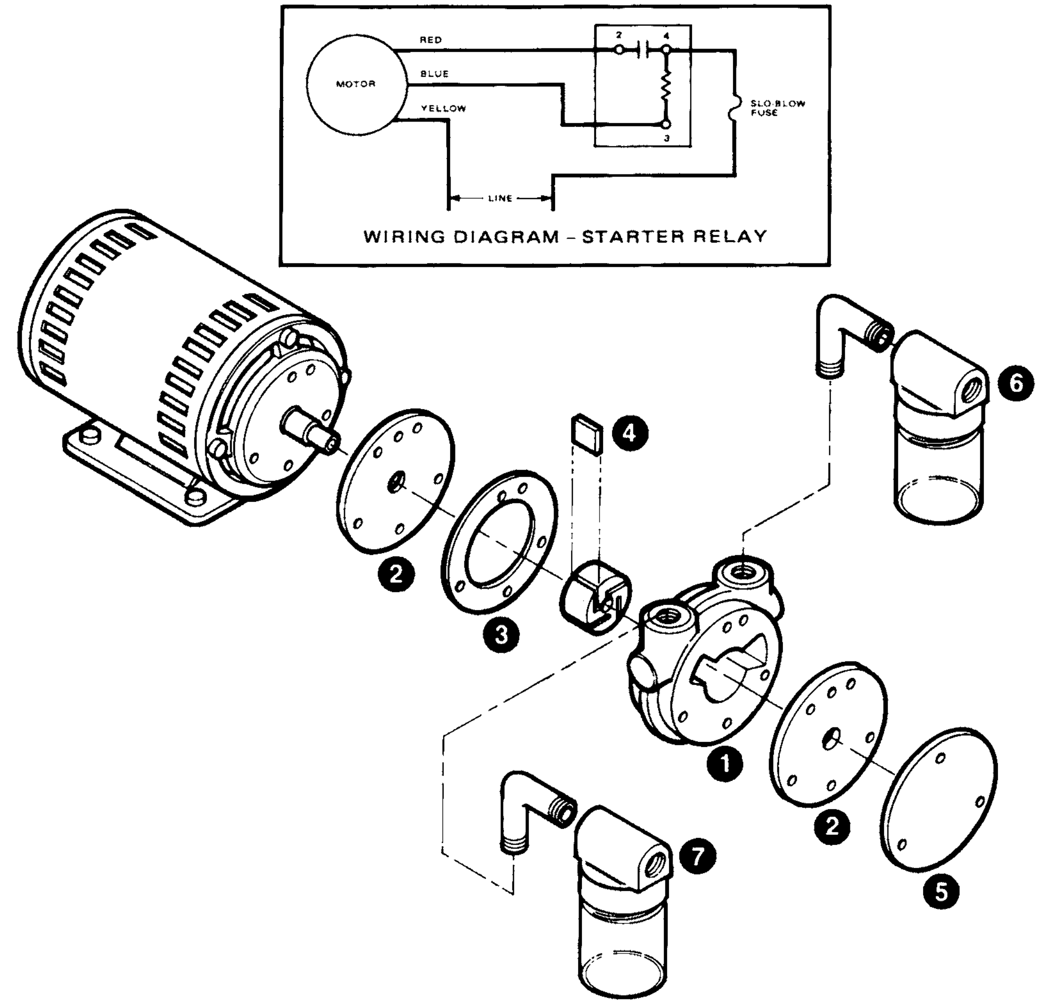
Gast Manufacturing Corp.
505 Washington Ave.
Carlstadt NJ 07072
201/933-8484

Brenner-Fiedler & Assoc.
16210 Gundry Ave.
Paramount, CA 90723
213/636-3206

Wainbee, Ltd.
121 City View Drive
Rexdale, Ontario,
Canada M9W 5A9
416/243-1900

Wainbee, LTD.
215 Brunswick Blvd.
Pointe Claire, Montreal,
Canada H9R 4R7
514/697-8810

Table A1. Parts List



Ref. No.	Description	Ampex Part No.	Quantity	1531 Series Gast P/N
1	Body		1	AG300
2	Insert (Wear) Plate	811-859	2	AG293
3	Body (Spacer) Gasket		1	AG296
4	Vane	592-048	4	AD979
5	Retainer Plate		1	AG297
6	Intake Filter		1	
7	Output Filter		1	

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